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WORLD SURVEY OF TANTALUM ORE

BY

JAMES S. BAKER

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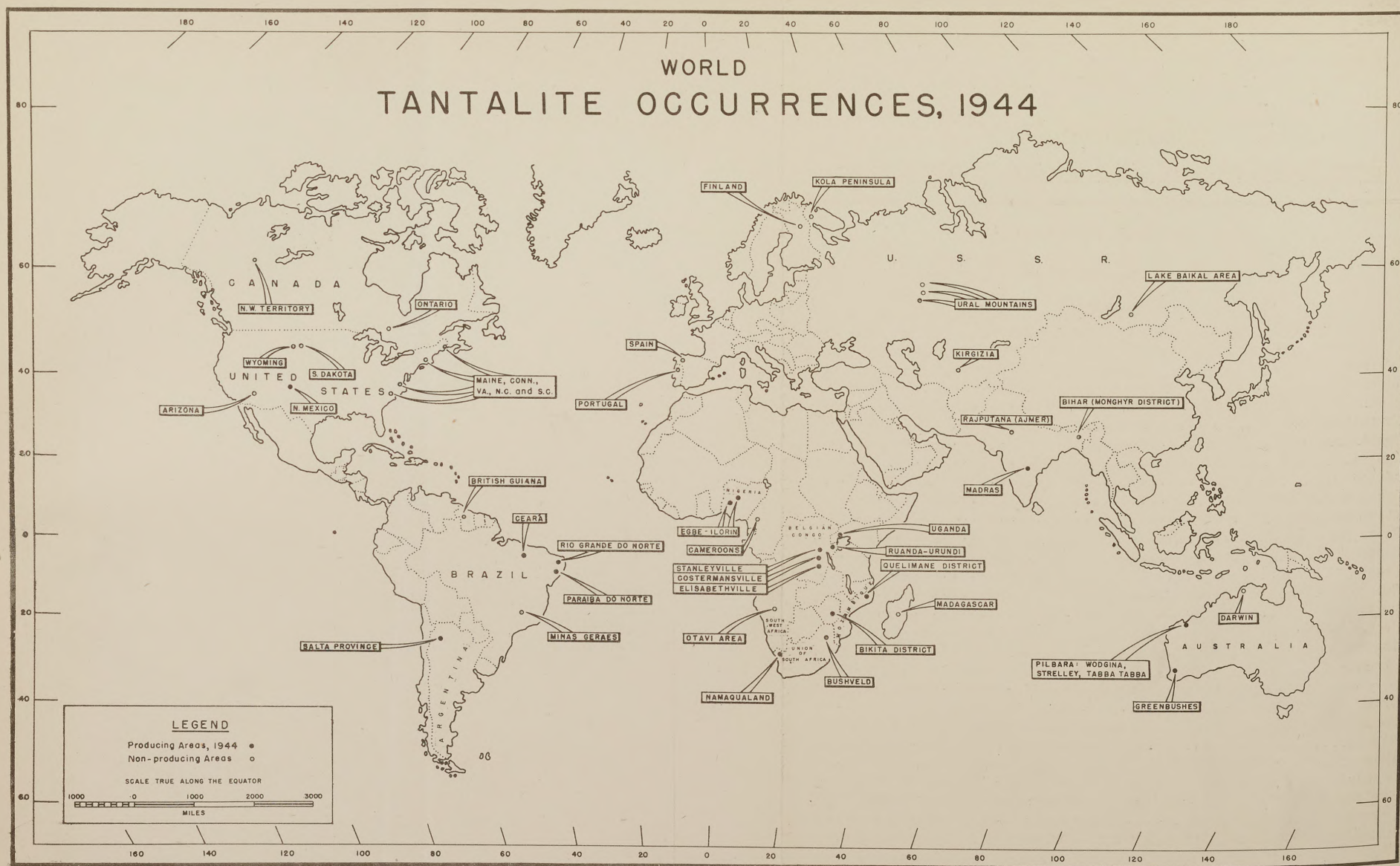
WORLD
TANTALITE OCCURRENCES, 1944



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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

WORLD SURVEY OF TANTALUM ORE[1]

By James S. Baker[2]

CONTENTS

	Page
Frontispiece	
Introduction	2
Geological and geographical occurrence	3
North America	3
South America	7
Australia	11
Africa	12
Other world deposits	20
Production methods and costs	22
South Dakota	22
Australia	23
Brazil	25
Southern Rhodesia	29
Transportation	30
World consumption and uses	30
Substitutes	31
Price trends	31
Prices, production, and consumption	31
Processing facilities	32
Government controls	32
Appendix	33
Principal tantalite deposits, Brazil	33
Schedule of prices and penalties for foreign tantalite ores	46
Revised schedule of prices and penalties for foreign tantalite ores	47
Mines and producers, Belgian Congo and Uganda	48

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2/ Chief, Rare Minerals Section, Foreign Economic Administration.

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ILLUSTRATIONS

Fig.		Follows page
1.	Principal tantalite areas, Northeast Brazil	6
2.	Tantalite deposits, Australia	10
3.	Principal tantalite areas, Belgian Congo and Uganda ...	12
4.	Leaseholds in Egbe tantalite district, Kabba Province, Nigeria	14
5.	Tantalite areas, Rhodesia and Mozambique	18

INTRODUCTION

Tantalum is a rare metal discovered in 1803 by Ekeberg. More than 1(years elapsed before it was used commercially (1905) and then only in neg gible quantities until 1941. Technological developments were slow in in- creasing tantalum consumption. Consequently, mining the ore was an unsta business, and little detailed information on the various world deposits h been recorded, owing primarily to lack of interest in such deposits by economic geologists and mining engineers.

During the years 1922 to 1941 uses gradually expanded as the unique properties of the metal became known to industry. In 1940 consumption of tantalite for metal production in the United States was 19 short tons, as compared with an estimated consumption abroad, chiefly in Germany, of ap- proximately 16 to 20 tons. The aerial bombardment of Britain in 1940 and 1941 proved the value of radar and soon resulted in greater production de mands for metal in the United States. In 1941 expansion of domestic pro- cessing facilities indicated the necessity for greatly increased ore supp of 45 percent Ta_2O_5 average grade to meet needs.

In 1941-42 the War Production Board and the Board of Economic Warfar strongly emphasized the need for augmenting the ore supplies of the Unite States, which are derived almost wholly from foreign production. Domesti stocks were gradually increased to a safe reserve through the cooperation of various United States Government agencies and foreign governments as well as private companies, both domestic and foreign.

Tantalite and columbite are found in pegmatites. It is difficult fo the inexperienced to identify either if they are associated with cassiter ilmenite, or wolframite, all high-specific-gravity minerals.

Tantalite and columbite are isomorphous mixtures in nature, and the name of the mineral usually is determined by the relative percentages of each in the occurrence. If the tantalum pentoxide content is higher than the columbium pentoxide, the ore is called tantalite; but if the columbiu pentoxide content is higher than the tantalum pentoxide, the ore is calle columbite. This is the usual technical description.

However, for metal production tantalite must contain not less than 3 percent Ta_2O_5, preferably 45 percent, and not less than 60 percent combi Ta_2O_5 plus Cb_2O_5 to permit economic recovery of the metal. Columbite, t

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used by industry, must contain 45 percent (minimum) Cb_2O_5 and 10 times as much Cb_2O_5 as Ta_2O_5.

In most publications relating to tantalite and columbite the two have been discussed together. This discussion is limited to ores defined here for metal production. However, the methods of processing and the end uses of the products of tantalum and columbium are quite different and should be considered separately. Recovery of tantalum, as discussed briefly in this circular, is an involved chemical dissolution and precipitation process. In the recovery of columbium electric-furnace treatment reduces the ore to a ferro-alloy.

Technical proficiency in reducing both tantalite and columbite is unusually high in the United States. Today, this country is supplying the entire United Nations needs for tantalum metal and other tantalum products. Before the war other consumers of tantalum preferred to procure the more-uniform and pure metal from the United States rather than metal from other sources.

Space will not permit more than a brief presentation of the salient points of general interest.

Reports from field representatives of the Foreign Economic Administration have supplied a large part of the data contained herein.

GEOLOGICAL AND GEOGRAPHICAL OCCURRENCE

Although tantalite is distributed widely throughout the world, only a few occurrences are considered commercially important. Many discoveries have proved of mineralogical interest only. Each section of the world will be discussed separately.

Tantalum ores are very rare and always are found in pegmatite formations or in eluvial and alluvial concentrations resulting from the erosion of pegmatite. Production in all areas where small concentrations of tantalum ores occur begins with the recovery of the coarser eroded material; rarely are the pegmatites mined by usually accepted methods. In some countries where the scale of wages is low, the natives mine by crude methods.

North America

United States. - According to Guiteras,[3/] the first tantalite in the South Dakota Tinton district was discovered near Tinton in 1927 in the course of road building. In 1928 a beneficiation plant was constructed, and about 12 tons of tantalite concentrates was produced. The operation closed early in 1929 after some underground development work had disclosed the extensive pegmatite zone in the central part of Tantalum Hill near Tinton.

3/ Guiteras, Jos. R., Mining and Milling Methods and Costs at the Black Hills Tin Co., Tinton, S. Dak.: Bureau of Mines Inf. Circ. 7084, 1939, p. 4.

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In 1935 this South Dakota operation was resumed but primarily for a blygonite, and in April 1937, Fansteel Metallurgical Corporation, the lar producer of tantalum products in the world, took over the plant and oper it until August 1938, when it was again discontinued. Fansteel Metallurg Corporation reported that 100 tons of rock had to be mined to produce 40 pounds of tantalum.

Geological formations have been adequately discussed by Darton and Smith,[4] of the Geological Survey, and Hess and Bryan,[5] of the Bureau of Mines. Production of tantalite from this area was recorded by Johnson[6] follows:

TABLE 1. - Tinton (S. Dak.) tantalite production

	Pounds
1928	17,263
1929	8,962
March 1937 to August 1938	17,279

Since 1938 only an occasional lot of a few hundred pounds of ore has been shipped from this area.

Other domestic occurrences of tantalite, largely of academic interes have been reported from various localities. The pegmatite zones in Main which have long been a source of mica and feldspar, yield negligible quan ties of tantalite. Pegmatites in the Appalachian region contain some tan but few commercial concentrations have been found. Specimens have been in studies of mineralization in Connecticut, Virginia, North Carolina, S Carolina, and Georgia. Extensive erosion of the Appalachian region has some places produced small concentrations in alluvium, particularly in N Carolina.

Occasional specimens have been reported from the Bagdad (Ariz.) reg usually by itinerant prospectors.

More recently, considerable interest has been aroused in the Hardin pegmatites in western Taos County, N. Mex., where slightly more than 3 t of microlite, a calcium tantalate, and about 500 pounds of tantalite wer mined in 1943. Later examination by the Bureau of Mines and the Geologi Survey have indicated that a minimum of 25 tons can be mined from a flat lying pegmatite.

4/ Darton, N. H., and Smith, W. S. T., Sundance, Wyoming-South Dakota: Geol. Survey Geol. Folio 127, 1905.

5/ Hess, Frank L., and Bryan, Barnabas, Jr., The Pegmatites at Tinton, Dak.: Bureau of Mines Report of Investigations 3404, 1938, 19 pp.

6/ Johnson, Arthur I., Tantalum from the Black Hills: Eng. and Min. J. vol. 139, No. 11, November 1938, pp. 39-42.

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Jahns and Wright have described the zones in detail. An abstract[1] of their work follows:

> The Harding pegmatites of western Taos County, N. Mex., though generally known as sources of spodumene and lepidolite, have become during the past year the foremost domestic source of the vital war metal tantalum, with a production of nearly 4 tons of concentrates containing 71 percent Ta_2O_5. The chief tantalum mineral is microlite, but appreciable amounts of tantalite-columbite and hatchettolite are present. More than 500 pounds of coarse tantalite-columbite - averaging 45 to 55 percent Ta_2O_5 - has been recovered from small placer deposits tributary to the pegmatites.
>
> The pegmatite of principal interest is a dike that lies within a zone of thrust faulting in steeply dipping metamorphic rocks of pre-Cambrian age. It dips southward at a very low angle, has an average thickness of 50 to 55 feet, and is known to contain beryllium, tantalum, and lithium minerals for distances of 350 feet along the strike and 650 feet down the dip. This dike is strikingly layered, each layer consisting of a distinct rock type whose relative position within the dike is remarkably consistent, although a given layer may show considerable variation in thickness. The zoning has been helpful and a reliable guide for recent predictions of ore-mineral distributions.
>
> Most of the beryl occurs in two marginal zones of quartz-microcline-albite-muscovite pegmatite, one along the upper and the other near the lower contact of the dike. Twenty tons of high-grade beryl have been hand-sorted from a small portion of the hanging-wall layer. A large body of microcline-spodumene-quartz-mica-plagioclase rock which contains minor tantalum minerals lies below a well-defined quartz layer in the central portion of the dike; replacement of the microcline and spodumene by lepidolite has yielded several large bodies of lithium ore. Most of the high-grade microlite concentrations occur in spodumene-quartz-purple muscovite rock which lies above a zone of strong albitization in the lower half of the dike.
>
> This unique zone is the largest known body of microlite in the world. Further exploration may disclose an even larger deposit of high-grade tantalum ore.

Canada. - Small quantities of tantalite, seldom more than a few hundred pounds at a time, have been shipped from Canada to the United States for processing. Sources of this production are western Quebec and eastern Ontario. The output has been irregular, and no actual production statistics are available.

---

[1] Jahns, Richard H., and Wright, Lauren P., The Harding Beryllium-Tantalum-Lithium Pegmatites, Taos County, N. Mex.: Econ. Geol., vol. 39, No. 1, January-February 1944, pp. 96-97.

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In 1942 the Moneta Procupine Mines, Ltd., noted extensive pegmatite a porphyritic rocks in the vicinity of Amos, Figuery Township, Quebec. Dr. A. W. Derby reported one dike closely associated with other pegmatites ave aging 4 to 6 feet in width, which had been traced for a distance of 110 fe Mineralization is rather irregular, a characteristic of such formations. the vicinity of the dike area the country rock is an agglomerate and volca tuff. Extensive faulting and fracturing was noted.

In 1942 and 1943 work under the direction of Dr. A. W. Jolliffe[8/] in Yellowknife-Beaulieu area of the Northwest Territories disclosed extensive pegmatite formations in diorite and granodiorite. High-grade tantalite wa found near Upper Ross and Redout Lakes. Of several hundred pegmatites ex- amined, 60 revealed tantalite-columbite mineralization. The dikes are up 500 feet in length and 40 feet in width, strike northwest, and dip steeply to the east. The specific gravity of selected specimens from several dike ranges from 7.2 to 7.87. The property owners in the area from which these specimens were obtained are J. R. Saunders and Radium Luminous Industries, Ltd.

Jolliffe states:

> The pegmatite bodies consist largely of feldspar, quartz, and muscovite in irregular mixtures and intergrowths. Few of the dikes show any marked banding parallel to the walls, although quartz is quite common as a band or as disconnected lenses along and near the center of a dyke. The feldspar includes both microcline-perthite and albite. The former is in crystals up to more than a foot across, in part showing ragged, partly replaced borders. Albite is in smalle aggregates, some of which exhibit the radiating lamellar habit of cleavelandite. Rare-element minerals identified with reasonable cer- tainty include (in about their order of relative abundance) beryl, tantalite-columbite, tourmaline, lithiophilite, and lazulite.
>
> Tantalite-columbite occurs in blocky crystals up to 2 inches square and several inches long and in plates up to 2 inches by 4 inches. It occurs characteristically within albite near quartz lenses but was found in each of perthite, quartz, muscovite, and beryl. It appears to be most common in the medial and upper parts of the dykes. Some dykes only 4 inches across contain tantalite- columbite.

Some samples contain as much as 82.37 percent combined tantalum and columbium pentoxides, the Ta_2O_5 content ranging up to 75 percent, as indicated by specific gravity. Although undeveloped, the Yellowknife peg tites may prove to be a commercial source of tantalum when the area is su ficiently opened to permit regular mining operations. The isolation of t

8/ Jolliffe, A. W., Rare-Element Minerals in Pegmatites, Yellowknife-Bea lieu Area, Northwest Territories: Canada Dept. Mines and Resources, Mines and Geol. Branch, Geol. Survey Paper 44-12, 1944, 23 pp.

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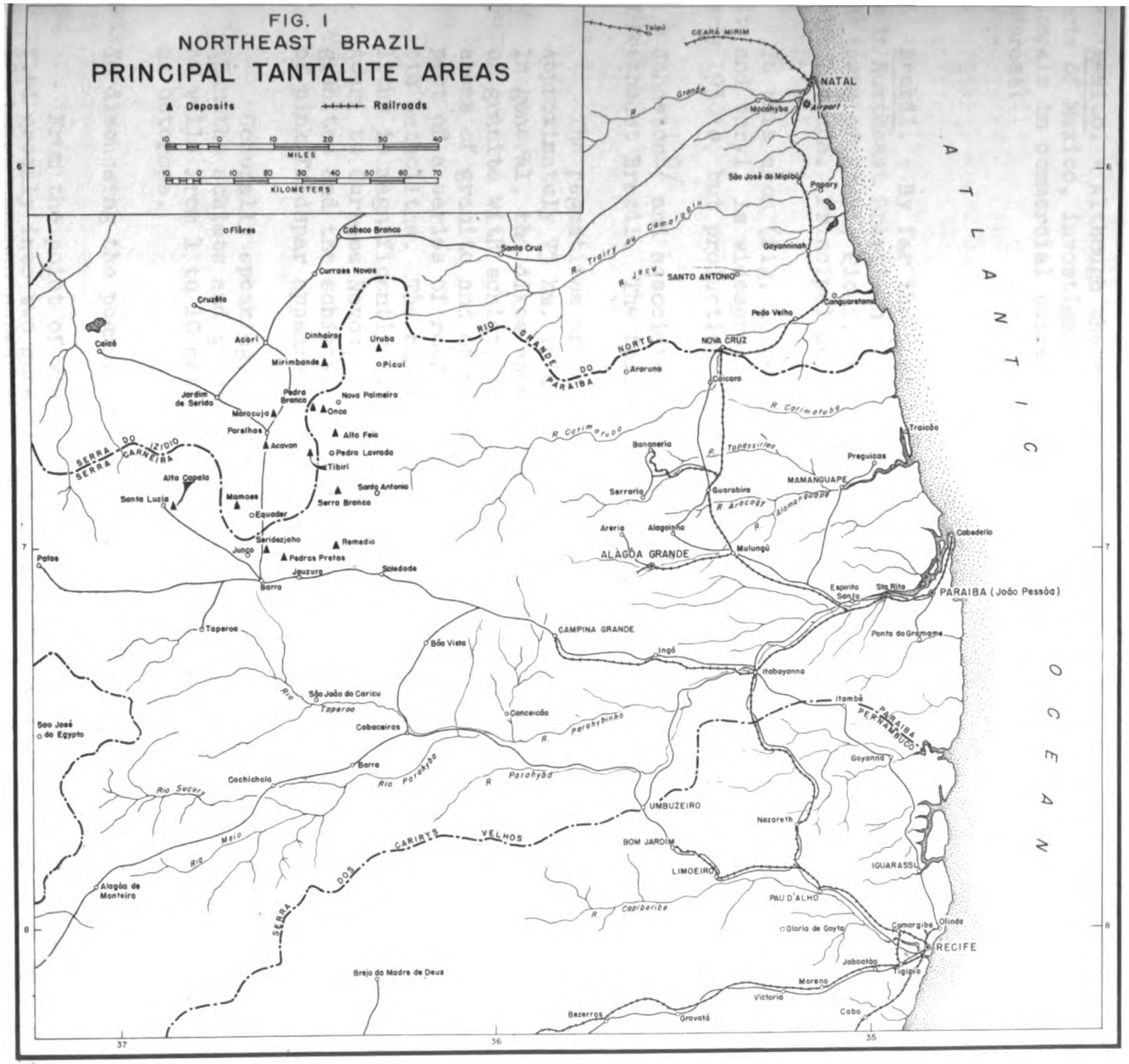

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area with the attendant difficulties of communication by lake steamer during the summer and by air in winter will make operating costs unusually high. Hence, operators will find it necessary to derive revenue from production of associated minerals other than tantalite.

Mexico. - Although there are numerous pegmatite occurrences in various parts of Mexico, investigations to date have failed to disclose tantalum minerals in commercial concentration. Further work may reveal deposits of interest.

South America

Brazil. - By far the most important tantalite-producing area in the world is in Northeast Brazil in the States of Rio Grande do Norte and Paraiba, near the towns of Acari, Picui, Jardim do Serido, Currães Novos, Parelhas, and Pedra Lavrada. Principal deposits are tabulated in the appendix.

In this area (fig. 1) pegmatite mineralization, productive of both tantalite and beryl, is widespread. Tantalite was discovered in Brazil in the early 1930's, but production was negligible until 1939.

Johnston[9/] and associates have described in detail the pegmatite area of Northeast Brazil. The following extracts are taken from their report:

> The pegmatites are distributed in an irregular manner in an area approximately 75 km. in a north-south direction, 50 km. east-west. In general, the dikes show themselves to be abundant near the contacts of granite with schist, the less frequent in the interior of large areas of granite and of schist. The region presents the general aspect of a series of roof pendants of schists and quartzites in granitic batholiths. The complexity of the border facies of these batholiths is magnificently displayed in the road cuts of the new road from Acari to Currães Novos, where there are many contacts between the granites and the schists. A grey porphyritic granite with phenocrysts of pink feldspar appears to be the most recent intrusive.
>
> Generally speaking, the pegmatites are more resistant to erosion than the schists and quartzites and therefore appear in many places as walls from 1 to 10 meters high, immediately recognized from afar as outcrops.
>
> . . . .
>
> In discussing the pegmatite dikes the authors state:
>
> From the point of view of texture, the pegmatites can be classified grossly into two general types: (1) Homogeneous pegmatites; and (2) heterogeneous pegmatites.

9/ de Almeido, Sandoval C., Johnston, W. E., Jr., Scorza, Evaristo P., Leonardo, Othon H., Pegmatitos com Berilo, Tantalito e Cassiterito da Paraiba e Rio Grande do Norte: Mineraçao e Metalurgia, vol. 7, No. 9, July-August 1943, pp. 115-126. (Translated by John Van N. Dorr, Geological Survey.)

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The homogeneous pegmatites are generally the larger. One of these, east of Picui, near the frontier between Paraiba-Rio Grande do Norte, measures more than 40 meters in width and was followed along the outcrop to a length of somewhat more than 2 km. It is composed of feldspar, quartz, and muscovite, with an average grain size of 2 to 5 cm. Most of the dikes in the form of walls in the region are of the homogeneous type. This type has no economic interest.

The heterogeneous pegmatites contain beryl, tantalite-columbite spodumene, and other minerals. They are characterized by a high degree of internal differentiation. Grain size is very great; they contain crystals in the order of 1 meter in length of feldspar, quartz, beryl, and spodumene and are commonly around a center nucleus of cle quartz or rose quartz.

The center nucleus of quartz appears to be an excellent guide t mineralization. Owing to its resistance to erosion, it forms slight elevations from a few to more than 100 meters of elevation, locally known as "altos." Consequently the heterogeneous pegmatites are conspicuous topographic elements. The pink coloration of the nuclei makes them conspicuous. Generally the pegmatitic nuclei can be distinguished from quartz veins which sometimes occur in the region by the fact that the latter have a more wall-like form with straight sides, and are without the impressions of crystals of beryl, feldspa or spodumene which are usually visible in the quartz nuclei of the pegmatites.

At first little was known about proper cleaning of the ore; in conse quence deliveries generally were not acceptable to industry. As the min and dealers became more familiar with the various minerals contained in t ore, cleaning methods were improved and the demand for the ore increased.

Exports in 1939-40 are shown in table 2:

TABLE 2. - Tantalite exports, Brazil, pounds of ore[1/]

Destination	1939	1940
United States	14,222	37,726
United Kingdom	23,842	-
Germany	6,612	8,846
Japan	6,612	13,224
Sweden	2,204	-
Total	53,492	59,766

1/ Commércio Exterior do Brasil, Importacão e Exportacão de Mercádorias por Paises: Ministerio da Fazenda, Rio de Janeiró, 1941, 342 pp.

The tantalite-bearing pegmatites in Northeast Brazil are prominentl posed, the elevations or altos commonly standing as much as 10 meters ab the otherwise somewhat regular land surface. The Brazilian miners have

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orked the properties by primitive methods but through experience have learned o concentrate their efforts upon the more-productive types of dikes. They leaned the eluvial and alluvial concentrations of the coarser particles and xcavated the tantalite-bearing zones in the pegmatite until the walls eakened and the workings caved. They then abandoned the workings and began igging at a nearby promising location.

These "gopherlike" methods crisscrossed the altos with crude workings in uch a complex manner that many of the pegmatite bodies were rendered unwork-ble; the result was loss of potential ore before mechanized mining of known roductive zones was introduced.

Whole families were engaged in mining and cleaning the ores. Sales were ade locally in quantities of a few pounds at a time in various market places nd through stores to itinerant buyers, who in turn sold the ore to the rincipal dealers and exporters.

In 1941, because of the urgent need for increased imports of tantalum re into the United States, U. S. Government agencies began purchasing ore n Brazil. Under the direction of the United States Purchasing Commission eological and engineering work was undertaken to stimulate production. The eological investigations of Johnston and others constituted a part of this rogram. Several hundred mines were examined in the Rio Grande do Norte and araiba area, and some development work was done on the pegmatites that ppeared most promising.

Examination of the tantalite area by American engineers early disclosed hat in order to obtain the desired production for war industries it would e necessary to improve mining methods, supply tools and equipment, and technically direct mining operations. Equipment and engineering assistance ere furnished as rapidly as possible, and mining operations of the principal roperties were placed on a more-uniform basis, although Brazilian methods ere not entirely displaced. Planned operations and modified open-pit mining ere substituted for the crude practices of many native miners. In addition to increasing production, these improvements facilitated geological studies.

Certain Brazilian mining laws did not permit production at the rate re-quired for the war program. However, upon being advised by the Department of Mineral Production that existing laws sometimes limited tantalite pro-duction and prevented the opening of new altos, the Brazilian Government made the necessary changes to facilitate prompt approval of mining applica-tions from producers.

In October 1943, 386 "mines" were in operation, compared with 150 in June. Various deposits examined in Paraiba and Rio Grande do Norte, indi-cated that tantalite production could be increased to as much as 40 metric tons per month. Undoubtedly 20 tons per month could be supplied for a period of 2 years from partly explored properties. In addition to the properties that have been examined, there are numerous potential deposits about which little information is available.

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The district around the town of Lages in Northern Rio Grande do Norte, due west of Natal, appears less promising than the area described, although there are a number of pegmatite occurrences in the area, as well as eluvial and alluvial concentrations; some of the dikes contain cassiterite, columbite, and some tantalite. Their value, however, is discounted primarily because of lack of water for concentrating the product. Preliminary dry-washing tests have not yielded encouraging results.

The State of Ceara is becoming increasingly important as a source of tantalite, although virtually unknown until late 1942. Many properties sho considerable promise, particularly those at Quxada and Cascavel near Guran Recent production has been won from hand-sorted alluvial deposits.

In Southern Brazil tantalite deposits have been reported in Minas Geraes, in the vicinity of Governador Valadares, and in various other regions, but none of these now indicate favorable production possibilities.

Argentina. - Occurrences of tantalite are scattered in the States of Cordoba, La Rioja, and Catamarca. The more-extensive pegmatite zones containing tantalite are in the heights of the Andes. The Honduras and Organullo mines are on the western border of Salta Province near its boundary with Los Andes Territory at an elevation of approximately 4,000 meters.

The Honduras area was examined in 1943 by W. D. Smith[10/] of the Geological Suvery, U. S. Department of Interior, who reported the principal country rock to be a fine-grained "spotted" schist containing abundant sma elliptical aggregates of micaceous minerals probably derived by remetamorp of an original metamorphic mineral, such as, perhaps, chiastolite. The spotted-schist area is estimated to be 16 km. long and 8 km. wide and contains more than two dozen pegmatite dikes.

In general, the schist strikes N. 45° E. and dips steeply to the west The pegmatite dikes cut the schist, strike N. 30° W. to N. 50° W., and dip almost vertically. Because of the steep relief of the country and the alt tude of the dikes, many of the dikes are well-exposed on the valley sides and hilltops and therefore can be easily prospected. The dikes are compos essentially of microcline, plagioclase, muscovite, and quartz but also car accessory minerals such as black tourmaline, spodumene, and amblygonite. Tantalite is distributed through the pegmatite masses in clusters of black crystals and in massive form.

Total production through the first half of 1944 has been small and re tively low-grade (40 percent Ta_2O_5), and operations have been very indefi Future prospecting and exploration may produce more-encouraging results.

10/ Smith, W. D., Report for the Board of Economic Warfare: Geol. Survey May 7, 1943.

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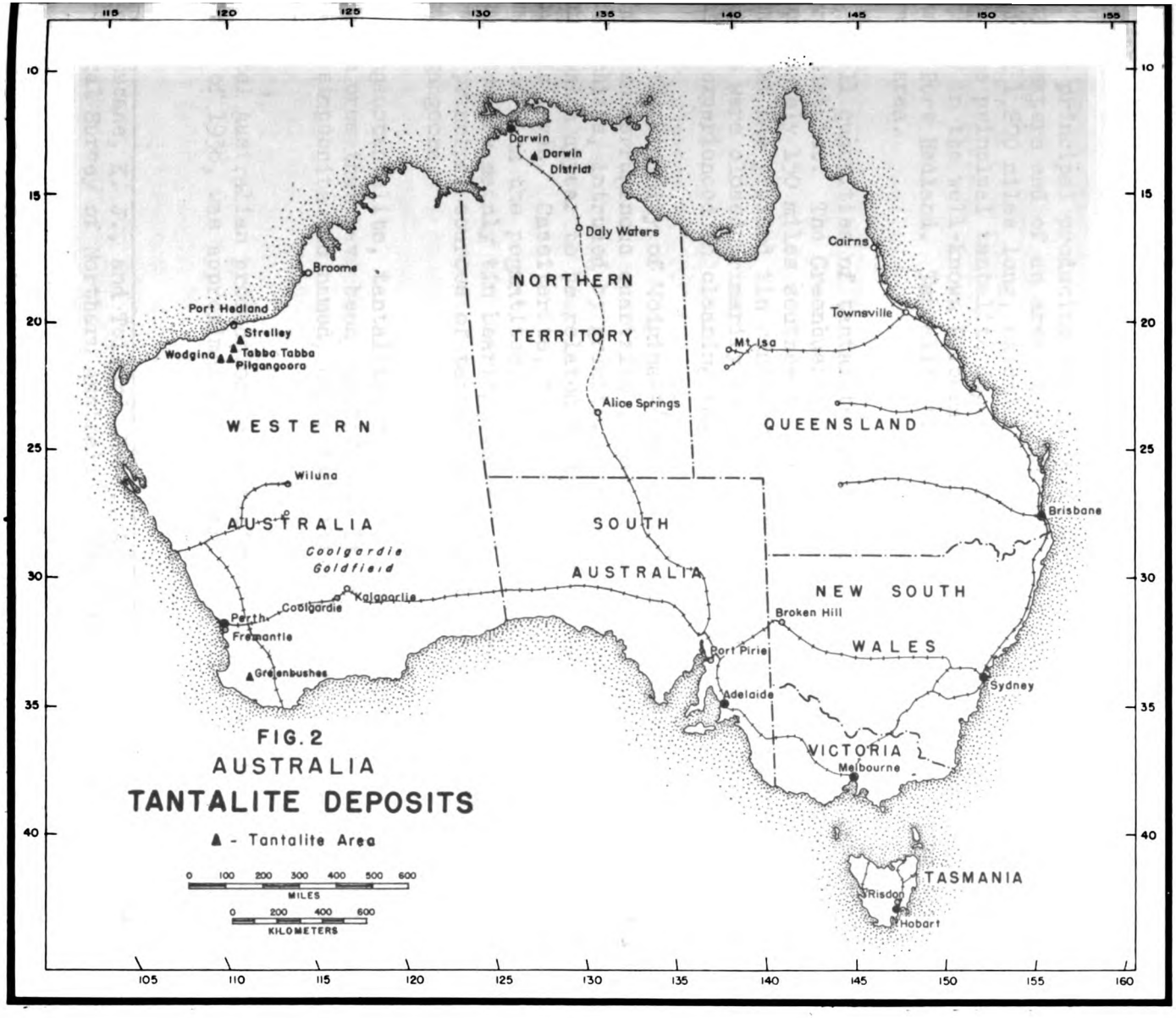

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Australia

Deposits of tantalite have been known in Australia since early 1900, first production having been recorded in 1905. Before 1938 Australia was the principal world producer of tantalite and the chief source of supply for the United States.

The principal producing region is in Western Australia, near Port Hedland, at the western end of an area of pegmatite mineralization, about 250 miles wide and 1,200 miles long, extending from Darwin to Hall's Creek (fig. 2). The three principal tantalite deposits are at Wodgina, Tabba Tabba, and Trelley in the well-known Pilbara mining district 40 to 70 miles east-southeast of Port Hedland. Tantalite also is known at Pilgangoora in this same general area.

Small quantities of tantalite occur near West Arm and Finniss in the Darwin district. The Greenbushes deposit is in southwestern Australia, approximately 150 miles southeast of Fremantle. This is an alluvial occurrence that has yielded tin concentrates containing tantalite-columbite. The diggings were closed primarily because of this contamination and the difficulties experienced in cleaning the tin ores.

In the vicinity of Wodgina[11] the rocks are ferruginous quartzite, slates, nonferruginous quartzites, basic lava flows, and carbonatized chloritic schists, intruded by granite. Numerous pegmatite dikes and quartz veins, which appear to be related to the granite, occur in the quartzites and basic lavas. Cassiterite, tantalite, and other accessory minerals are associated with the pegmatites. Pegmatite dikes enclosed by ferruginous quartzites are mainly tin bearing, whereas the pegmatites in the basic lavas are the principal sources of tantalite, as is likewise true at Tabba Tabba and Pilgangoora.

Manganotantalite, tantalite, microlite, and simpsonite are the various tantalum ores that have been identified. Dr. E. S. Simpson, after whom the mineral simpsonite was named, conducted research[12] on tantalum ores for many years.

Total Australian production, as reported by Finucane and Telford[13] to the end of 1938, was approximately 240 long tons.

1/ Finucane, K. J., and Telford, R. J., Aerial, Geological, and Geophysical Survey of Northern Australia. The Tantalite Deposits of the Pilbara Goldfield: Rept. West. Australia No. 46, Canberra, Australia.

2/ Simpson, E. S., Contributions to the Mineralogy of Western Australia: Jour. Roy. Soc. West. Australia, ser. 10, vol. 23, 1936-37.

3/ Work cited in footnote 11.

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TABLE 3. - Tantalite production, Western Australia, long tons

Year	Misc.	Wodgina	Strelley	Tabba Tabba	Total
1935	0.92	11.33	0.08	1.77	14.10
1936	-	8.83	2.04	4.11	14.98
1937	2.88	6.92	2.51	5.69	15.12
1938	2.64	10.86	5.77	.53	17.16
Total	6.44	37.94	10.40	12.10	61.86

TABLE 4. - United States imports of tantalite from Australia, 1937-42 1/

Year	Pounds	Year	Pounds
1937	20,897	1941	29,574
1938	30,684	1942	1,480
1939	30,004	Total	112,639
1940	-		

1/ Data from Fansteel Metallurgical Corporation Report to Board of Economic Warfare.

AFRICA

Pegmatite dikes occur in a great many areas of Africa. These are int sive in a variety of formations and as a rule are closely associated with granite. For a number of years some tantalite has been produced in variou parts of Africa, but before the war the annual output had declined to only a small tonnage from the entire continent. To fulfill the greatly increas war demands, all possible sources were investigated, and as a result many properties are now producing.

Belgian Congo. - The vast pegmatite zones of the Belgian Congo extend over 700 miles from Elisabethville district in the south to Ruanda Urundi in the north - through Tanganyika district, the Maniema district, the sout western tip of Stanleyville Province, and into the Ona-Kasese region (fig.

Detailed reports on the distribution and occurrence of tantalite in the Belgian Congo have been made by Dean F. Frasche, based upon an examination made in 1942, for the Board of Economic Warfare and by Louis Jouber in 1943 for the Foreign Economic Administration. Much of the following information is taken from these reports.

Tantalite deposits in the Belgian Congo are of three general classes: (a) Eluvial and alluvial, (b) high-grade tantalite in pegmatite, and (c) low-grade tantalite disseminated rather uniformly throughout the larger ti pegmatites. Production from the first two sources up to 1943 was negligib but since then has expanded and during the next few years should continue 1944 levels provided price and market conditions are stable. The tin-tant lite deposits are now being operated at the capacity of the treatment faci ties. Sizable low-grade ore bodies undoubtedly remain; the tantalite will recovered when they are mined. In general, the tin-bearing pegmatites are a zone of deep weathering.

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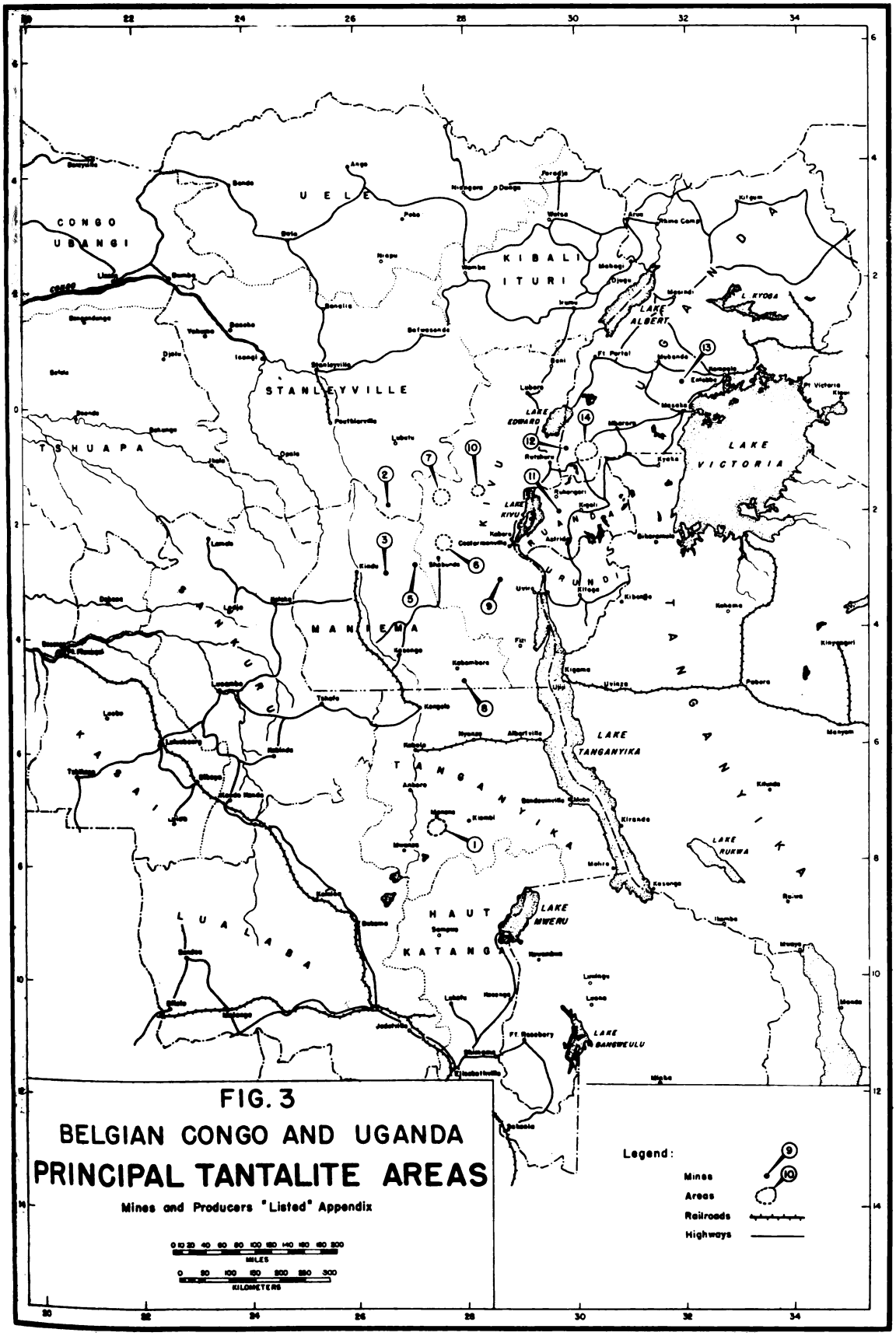

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The principal producer of tantalite in the Belgian Congo is the Compagnie Geologique et Miniere des Ingenieurs et Industriels Belges (Geomines), which likewise is the largest tin producer. Tantalite is a byproduct of the company's tin operations, being recovered from tin concentrates before they are smelted. These deposits are particularly noteworthy since they represent the only blocked-out tantalite-ore occurrences in the world. Future production, however, is related to plans for tin mining. The deposits have been described as follows:14/

> The cassiterite and tantalite are found in disseminated form in two large decomposed pegmatites which have intruded ancient schists. At the northern end of the property a later "dolerite" (?) has intruded the schist and pegmatites. Strike of the pegmatite zone is N. 37° E., and the dip is nearly vertical. Mineralogically, the pegmatites are composed of mica, feldspar, tourmaline, cassiterite, and tantalite. The tantalite is always found associated with cassiterite and appears to increase in quantity and quality toward the northern end of the pegmatite zone. As the cassiterite and tantalite are very fine-grained, they are rarely observed in the faces of the mine workings.

Analysis of the ore in the early stages of mining the pegmatites showed approximately 35 percent Ta_2O_5 and 30 percent Cb_2O_5. However, as mining continued, the Cb_2O_5 content had increased somewhat, while the Ta_2O_5 content had decreased. More recently, the grade has approximated 28 percent Ta_2O_5 and 30 to 35 percent Cb_2O_5.

As already noted, Geomines is the chief producer of tantalite concentrates in the Belgian Congo. Production began in 1934, and since then exports have increased. Table 5 shows tantalite exports from the Belgian Congo from 1934 through 1943 and an estimate for 1944.

TABLE 5. - Belgian Congo exports of tantalite-columbite, 1934-44 1/

Year	Pounds	Year	Pounds
1934	44,300	1940	226,095
1935	61,800	1941	-
1936	57,200	1942	202,154
1937	92,480	1943	242,198
1938	46,930	1944 (estimate)	310,000
1939	19,644		

1/ Data from Reports to Office of Economic Warfare.

14/ Rept. to Board of Economic Warfare, April 1, 1943.

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In the Maniema district various properties controlled by some of th smaller tin producers contain small but unknown reserves of tantalite. of these deposits produce relatively high-grade ore and are being mined supply war needs.

The tantalite producers of the Belgian Congo, exclusive of Geomines are grouped, for marketing purposes, under the Director of War Minerals duction and the Comite de l'Etain. This marketing arrangement was init by the Government of the Belgian Congo solely to aid the United Nations. The principal tantalite mines are tabulated in the appendix.15/

Little prospecting for minerals has been done in Ruanda Urundi. Ho ever, Minetain, Minefor, Mirudi, and Somuki control several deposits in territory. As work proceeds, the deposits in Ruanda Urundi indicates po bilities for continued production of high-grade tantalite on a small sca for several years to come.

Nigeria. - Tantalite has been known in Nigeria in the Ilorin or Kab tin area, Kabba Province, for many years, but before the war no interest been taken in its production. In tin-mining operations tantalite was co sidered a "nuisance" mineral; although it was commonly high-grade, littl consideration was given to its recovery. Mineralogical specimens were s from time to time, and a few small sample shipments were forwarded to Fa steel Metallurgical Corporation.

The Ilorin tin field covers an area of approximately 800 square mil The principal tantalite deposits are near the native village of Egbe, ab 85 east of Ilorin, on the main road from Ilorin to Kabba (fig. 4). Thes properties are controlled by M. L. Hamber and J. D. de Paravacini, both whom have had many years of mining experience in this area.

In the latter half of 1942 the Board of Economic Warfare, through t American consul at Lagos, was able to encourage production. Through his perience in the Ilorin tin field Hamber had gained knowledge of promisi deposits, mainly alluvial and eluvial, which proved invaluable, particul in early development work.

The principal factors that have limited production, as adequately s marized by Hamber, are: (1) Small tonnage available, (2) price uncerta ties, (3) market instability, and (4) lack of separating plant. Colonel Dent Young, director of Wolfram Production, reported in December 1942 th at least a half ton per month could be produced from the Egbe area if th four obstacles were removed. After examination of the deposits mining w begun, and by the middle of 1943 equipment for separation of the heavy minerals had been purchased in the United States and forwarded to the pr ducers. Funds were provided for dam construction to store water during wet season; during 1944 production probably has increased substantially

15/ Joubert, Louis J., Report for Office of Economic Warfare: August 1 1943.

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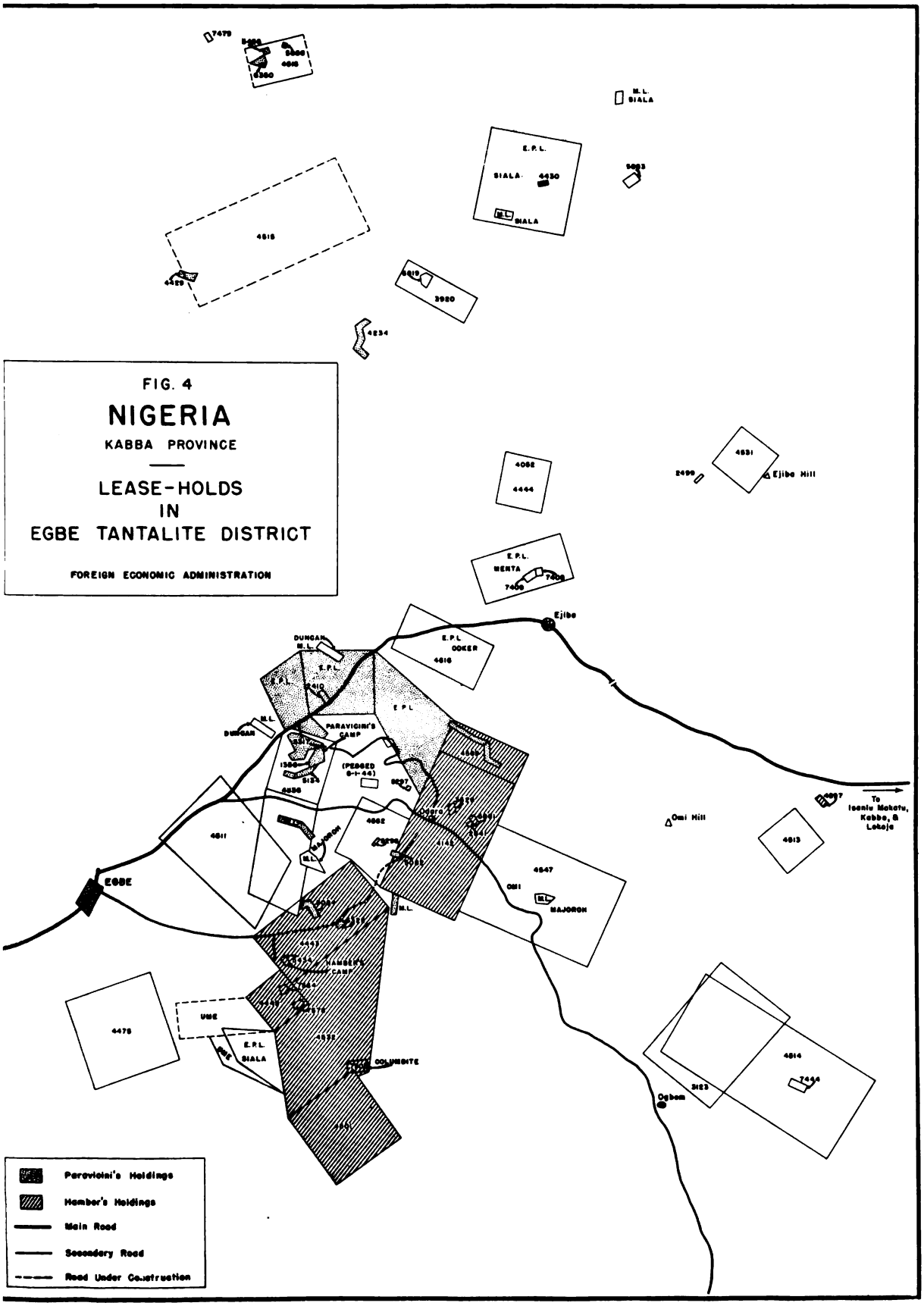

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Geological discussion of this region is of general interest and is well presented by Jacobson:16/

Soft micaceous schists and gneisses, together with associated amphibolites and granulites, are the predominant rock types in north-western Kabba. Older granite outcrops in the western part of the area, while pegmatite and quartz-reefs are widely distributed. The prominent ranges of hills, such as the Odokeri and Odara-Akata Hills in the main tantalite area, owe their existence to the hard bands of amphibolite, granulite, and reef-quartz. The pegmatite dykes weather comparatively easily and do not form any noticeable features. Talc, chlorite, sillimanite, cordierite, staurolite, and anthophyllite schists are locally abundant. The chief deposits of tantalite, columbite and cassiterite are associated with certain albite-rich pegmatites, while the gold is derived from the ubiquitous reefs and stringers of quartz.

The older granites outcrop as rounded inselbergs and are generally foliated, biotite-rich rocks with a wide range in texture. The "gneissose-granite" around Egve is a coarse, porphyritic variety, while immediately east of Oke Oloke there is a prominent ridge of granitic-gneiss with faint streaky schlieren. Other outcrops occur at Odo Oshin, Mari, and also probably at Isanlu Makatu. Veins, stringers, and occasional dykes of quartz-orthoclase pegmatite are common around Egbe and Okuna and are particularly abundant in the gneisses between Okuna and Oke Oloke. These pegmatites consist essentially of quartz and orthoclase with a little muscovite and biotite. Garnet is also usually present.

The pegmatites exhibit considerable variation in mineralogical composition and texture and are divided tentatively into three groups as follows:

(a) Albite-rich pegmatites.
(b) Quartz-muscovite pegmatites.
(c) Quartz-orthoclase pegmatites.

Late in 1943 the Office of Economic Warfare sent H. J. Evans to this area to examine the tantalite deposits. An extract of his report17/ follows:

The pegmatites are irregularly distributed over much of the area here delimited, and some of them contain sufficient concentrations of mineral to be of economic importance. The intensity of mineralization in the pegmatites varies considerably with the most notable field near the village of Egbe and also circled around the Wamba area in Plateau

16/ Jacobson, R. R. E., Columbite and Tantalite: Nigeria Dept. Mines, 1943.

17/ Evans, H. J., Report on Tantalite-Columbite - Its Sources, Development and Production in Nigeria: For. Econ. Adm., April 15, 1944.

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Province. As a general rule, in Nigeria they lack the common central core of massive quartz and aided by extremely active weathering agencies, the larger portion of the pegmatites have been eroded evenly with the surrounding formations. Many dikes of importance are partially covered with an abundance of soil and are secluded by a dense growth of thick and tall orchard grass. Some of the pegmatites, however, do contain small, irregular, and disconnected quartz fillers which have resisted erosion sufficiently to have formed small but not particularly noticeable knolls and they can be traced with difficulty. In the Kabba field near Egbe, some of the dikes contain abundant quartz and to a small extent, by resisting erosion, have helped to preserve the series of small mountain ranges existing there.

The pegmatites have structural features of all sizes and dimensions, with narrow widths but often traceable to extreme lengths. They have a variable and often fairly flat dip, conforming to the strike and foliation of the encasing formation. All the dikes of this area are characterized by a preponderance of quartz, very small amounts of feldspar, and with a marked development of thick small-blocked muscovite. With the usual proportion of feldspar lacking, the whole body of the pegmatite is uniform and presents the appearance of a highly silicious and consolidated veinlike mass of intergrown quartz-mica aggregate. The smaller pegmatites often carry appreciable quantities of tantalite and tin. Due to the smaller total amount of mineral discharged by erosion, they could and probably do often mislead the prospector in his effort to find eluvial deposits of economic importance.

The larger pegmatites, the only dikes of economic value, are sparsely scattered, generally but not always existing in the lower levels along the rims of the ranges. They form no conspicuous features of the general landscape. They are short in length, stubby, potbellied, and generally short and end very abruptly. They range in sizes of 20 to 40 feet in width and 200 to 400 feet in length and appear to have the normal vertical dip and distinct walls. Like the smaller and more profusely distributed dikes, they are composed chiefly of an irregular intergrowth of quartz and mica with minor amounts of albitized feldspar. The mica is made up of small, compact somewhat stained blocks and generally showing a twinned intergrowth arrangement of thick booklike structures formed in an unaligned manner throughout the entire mass.

Being of larger dimensions, they have through the long period of erosion discharged a proportionately greater amount of tantalite and cassiterite. These minerals liberated in greater quantity account for the erratic and limited residual deposits of economic grade now found below and near the pegmatite dikes.

In 1942, 1,138 pounds of high-grade tantalite was delivered to the United States and in 1943, 8,537 pounds. Deliveries in 1944 may approximate 30,000 pounds of high-grade ore. While the deposits were being pre-

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for mining and the dam was being constructed to store water, production increased. Beneficiation equipment also has been installed on the Hamber and Paravicini properties. Arrangements have been concluded whereby ores will be treated for other small producers.

The pegmatites in this area are in a zone of deep weathering, with heavy overburden. Low, rolling hills throughout the plateau region may or may not indicate pegmatite dikes. Further prospecting in fields remote from the Ilorin tin field in Kabba Province indicates that tantalite may occur near Wamba in the Plateau Province and near Abuja in the Minna district, Niger Province. Undoubtedly this newly opened tantalite area will prove of far greater extent than is now indicated.

Uganda. - Tantalite-columbite was identified in Uganda in 1928. At that time the extent of the deposits was unknown, and the ore was considered a mineralogical curiosity. Mining on a small scale was begun in 1935, but no exports were reported until 1936. Some rare ores have been recognized in this area, chiefly the very rare bismutotantalite.

Before 1942 the principal ores exported were mixed tantalite-columbite of various grades. Germany and the United Kingdom were the main markets for these ores, although in later years the United States received small quantities. In 1943 delivery of high-grade tantalite was emphasized, and through the efforts of the Geological Survey of Uganda production from several deposits was expanded. Exports for 1936-41 are listed in table 6:[18/]

TABLE 6. - Exports of tantalite-columbite from Uganda

Year	Long tons	Year	Long tons
1936	18.49	1940	0.69
1937	27.66	1941	Nil
1938	8.9	1942	0
1939	2.8	1943	1/9.3

1/ Includes 2.78 tons of high-grade (45 percent Ta_2O_5) tantalite.

The principal productive deposits (fig. 3) are west and north of Lake Victoria, supposedly an extension of the pegmatite zones of Ruanda Urundi and the Belgian Congo. The main deposits reported by K. A. Davies are listed below:

	Ta_2O_5 content of specimens, percent
(a) Nyanga	50
(b) Kitofa	40
(c) Ruhuma	65
(d) Ningoma	70
(e) Nyabaseni	65
(f) Ngoma Weru	30
(g) Dweta	40

18/ Davies, K. A., Mineral Resources of Uganda: Uganda Geol. Survey, December 1942.

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These are in Ankole Province bounded on the west by Lake Edward, on north by the Katanga River, and on the east by Lake Victoria. In this di trict are mixed ores containing a high percentage of tantalum and columbi pentoxides as well as cassiterite. Some ores are columbium-rich. The principal deposits are in the vicinity of Dwata, Kashozo, and Ngoma.

The native chiefs in outlying districts north of this area long have refused to allow prospecting in their domains. However, some prospectors gained entry through friendly relations with the native rulers, and tanta lite deposits associated with pegmatite mineralization have been found as far north as the Kitgum area.

Production has not been consistent, primarily because of the uncerta ties of marketing the ore at a price that will provide a return for funds invested and labor expended. Another factor that has limited production Uganda is the difficulty of separating mixed tin-tantalite ore.

The Geological Survey of Uganda long has been interested in the poss bilities of producing tantalite. In December 1942 the Geological Survey reported in detail the tantalite and columbite occurrences in this Britis Protectorate. An extract from this report follows:

> Minerals containing columbium (niobium) and tantalum are wide- spread throughout the Protectorate. They include the area euxenite of Western Buganda, the koppite of the Sukulu limestone mass (Easter Province), the unique bismutotantalite of Nampeyo Hill north of Kampala, and at least one apparently undescribed mineral.
>
> These minerals have been recorded from places as far apart as Okollo in West Nile, Buswale in Southeast Uganda near the Kenya bor- der, and along the Uganda-Ruanda border.
>
> The occurrences of importance, however, are those discovered i the course of gold and tin mining in Ankole and Kigezi (Southwest Uganda). Here columbite-tantalite may occur separately or in close association with the tinstone, but its relationships to quartz and pegmatite bodies is always the same as that of cassiterite; there i a suggestion in some places, however, of a close association of col bium and tantalum minerals with phosphates.
>
> The veins occur where the Karagwe-Ankolean or Toro systems are intruded by the granite, and production has been obtained from lode both solely in the granite and solely in the sediments. Like many the tinstone lodes of Uganda those so far discovered carrying colum bite and tantalite are invariably small and erratic, and very few h paid to work under previous uncertain conditions of demand.

British Southwest Africa. - Namib Tin Mines have produced small qua ties of tin concentrates containing tantalite-columbite. These ores wer shipped to the United Kingdom except for a small lot sent to the United States in 1943 after it had been cleaned at the properties. Reserves of

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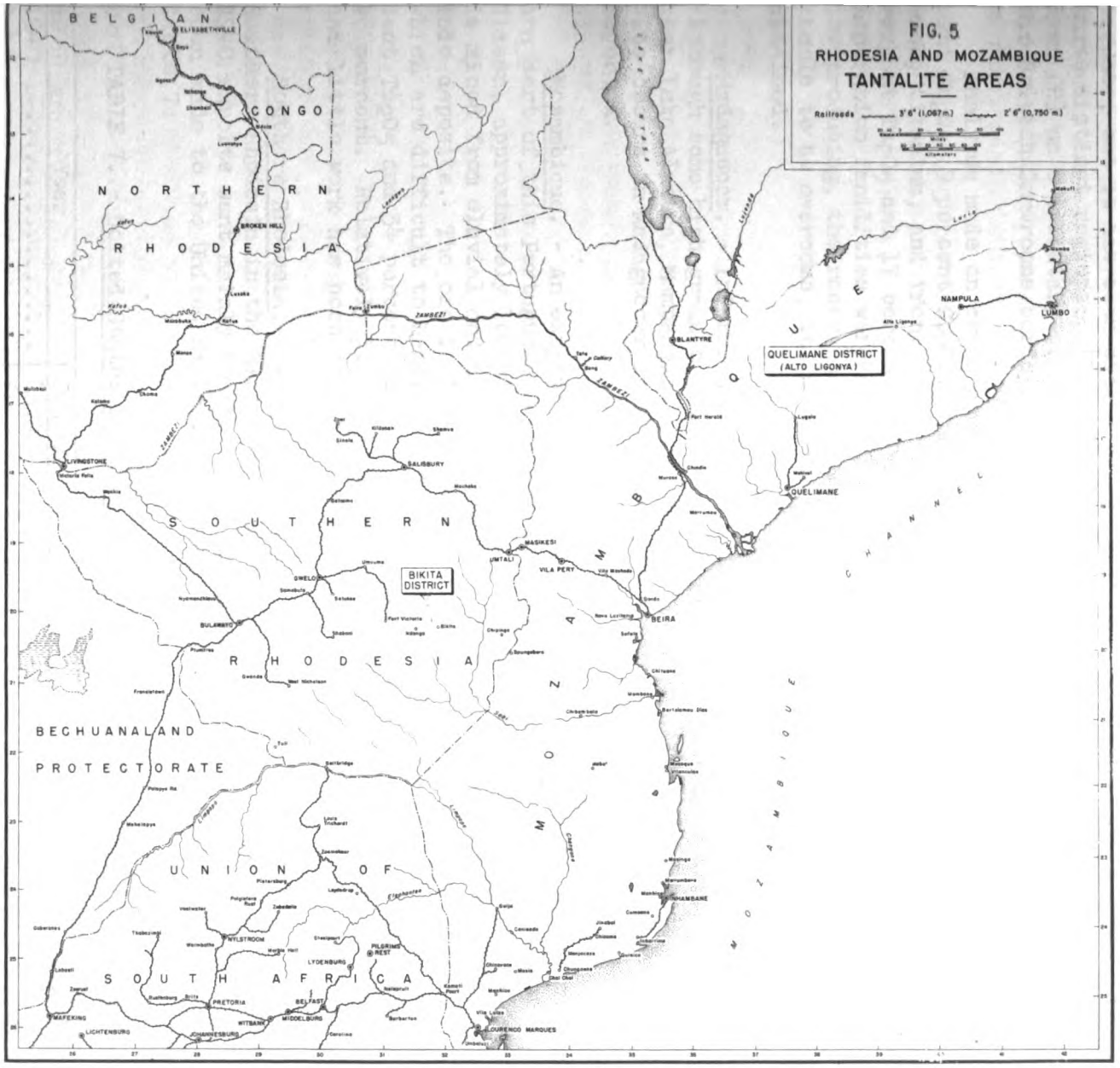

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this property are unknown. Mineralization, like most tin-tantalite pegmatite ore bodies, is typically erratic.

French Cameroons. - No production has been reported from this French mandate, but it has been consistently reported that tantalite is found in three distinct regions: (1) On a tributary of the Lom River near Botarebga, (2) on a tributary of the Mba, and (3) near the town of Dschang near the British Cameroons border.

Analyses made on crude concentrates from the Mba River showed 15 percent Ta_2O_5, 9 percent Cb_2O_5, and variable amounts of tin and quartz, manganese, titanium, and iron. It is reported that a concentrate containing 45 percent Ta_2O_5 and 17 percent Cb_2O_5 could be delivered provided magnetic-separation facilities were available. Although these properties are not now producing, the reserves are unknown, and their isolation is a big obstacle to be overcome, it is possible that worthwhile production can be attained.

Madagascar. - Information on tantalite deposits in Madagascar is meager, although some high-grade ore has been reported. Principal occurrences are near Lake Alaotra, Mampangabe, and Ambatofotsikey. Some high-grade columbite occurs in Madagascar in the same general area. No production has been reported.

Mozambique. - An extensive pegmatite area has been located in the northern part of this Portuguese colony in the Quelimane district, Province of Niassa, approximately 160 miles from the port of Lumba (fig. 5). Tantalite is mined from eluvial and alluvial deposits near the pegmatites and from lode deposits. The ore is low-grade and commonly occurs in large pieces, which are difficult to handle. Approximate analyses indicate 30 to 35 percent Ta_2O_5 and 34 percent Cb_2O_5. Occasionally the Cb_2O_5 content will exceed 48 percent. Relatively little information on these deposits is available, and little work has been done on them.

Southern Rhodesia. - For several years tantalite has been produced in Southern Rhodesia in the Bikita district (fig. 5), east of Victoria. Until 1940 exports went mainly to the United Kingdom. Small shipments have since been made to the United States. Available statistics are presented in table 7:

TABLE 7. - United States imports of tantalite from Southern Rhodesia[1/]

Year	Pounds	Year	Pounds
1940	11,404	1942	18,971
1941	64,773	1943	2/20,699

1/ Data from Rare Minerals Section, Foreign Economic Administration.
2/ Additional 11,213 pounds imported by United States from United Kingdom which represented accumulation of several years from a number of sources, chiefly Southern Rhodesia.

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The principal operator in this field had been mining on a small scale some sections of a pegmatite area that contains concentrations of tantalite. Since the pegmatite extensions indicated large production possibilities (up to 100 tons per year, as estimated by the Southern Rhodesian Department of Mines), the properties were taken over by the Government early in 1943 to produce tantalite from the entire district for war needs. A pilot plant was constructed, and mass mining of pegmatite was undertaken. This proved impracticable, and methods were altered to selective mining. The following quotation is taken from a report written in April 1943 by Arthur P. Cortelyou, consultant for the Foreign Economic Administration:

> The results of comprehensive sampling of eluvial, mill runs of rock taken from the pegmatite area, mill runs of Greisen and large-scale washings of selected eluvial area indicate that the whole area is very weakly mineralized and that the "hot spots" where there has been a concentration of values are few and far between and are insufficient to sweeten the mass to an ore where a large formal operation could be carried on successfully.

Notwithstanding the abandonment of mass mining, operations not only proved uneconomical but production failed to increase as originally expected. Consequently, the properties were returned to their original owners.

Union of South Africa. - Hugh R. Van Wagenen, head mining engineer for the Foreign Economic Administration, recently reported deposits in Namaqualand, in the vicinity of Steinkopf. These are north of O'Kiep copper deposits. Van Wagenen also reported tantalite deposits in the Transvaal.

Other World Deposits

Iberian Peninsula. - The wolfram ores of Galicia, Spain, and some of the ores in Portugal reportedly contain tantalite. It is said that tantalite has been separated from wolfram ores shipped to Germany. Alluvial tin concessions in Caminha, Portugal, are reported to contain columbite, tantalite, and gold in addition to cassiterite. Two samples from this source analyzed as follows: 50 percent Ta_2O_5 and 0.36 percent TiO_2; 52 percent Ta_2O_5 and 7.28 percent TiO_2. Another occurrence is reported in the wolfram concessions near Viano do Costelo.

Finland. - Columbo-tantalite has been found in the northern part of Finland, according to Karin Amark, of the Stockholm Hogskolas Mineralogiska Institut. Although this work was mainly a scientific investigation, it indicated occurrences of tapiolite, ixiolite, and other tantalum-bearing minerals in the Karutask pegmatite. In the vicinity of Skogbole numerous mineralogical specimens have been obtained in the course of pegmatite studies.

Norway. - Tantalite has been reported near Moss, Alstfolde, and Telemark and in Copparberg.

France. - Some small crystals of tantalite and columbite have been found near Limoges in the Chanteloube district.

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Germany. - Pegmatites occurring near Robenstein and Bodenmais, Bavaria, are said to contain occasional tantalite and columbite crystals.

Soviet Union. - Extensive pegmatite mineralization has been reported in the Soviet Union. Pegmatite deposits appear to have been mined chiefly for gem beryl, although the industrial pegmatite minerals have aroused some interest. Except for occasional references in geological reports and technical papers, little authentic information on these occurrences is available.

Transactions of the Mtril Geological Congress, Northern Excursion, report that the Kola Peninsula pegmatites in the Khibine, Lavozer tundras, contain tantalite. These pegmatites reportedly are typical of such granitic derivatives containing abundant albite and considerable quantities of heavy black minerals.

Tantalite occurs in the pegmatite areas of Georgia, in the Ural Mountains, and in the Kirgizia pegmatites on the north slope of the Turkestan Range. Vague rumors indicate that tantalite has been found in the Lake Baikal area of Siberia.

The various tin areas in Siberia, the Ural Mountains, and European Russia may likewise contain tantalite. The interest aroused by the need for greater ore supplies since 1941 probably will result in more complete data being assembled on the possibilities of producing tantalite in the Soviet Union.

India. - There are several extensive pegmatite areas in India, none of which has been fully examined geologically. Tantalite deposits, therefore, are indicated only by the small quantities of the ore that have been recovered in the course of other mining operations.

The better-known pegmatite areas are in the Monghyr district of Bihar near Jahajha, the principal source of mica production, and in the Rajputana area. Pegmatites that are not so well developed occur in the States of Mysore and Madras near Yelwel, Madura and Trichinopoly districts.

Vast pegmatite areas have been reported in the northern part of India in the Punjab, Kashmir, and Northwestern Frontier Province section. Although reports indicate that these pegmatites primarily are interesting as a source of beryl, they may contain some tantalite.

Small lots of tantalite have been shipped at various times to consuming centers. In 1943, 936 pounds of ore, representing an accumulation over a long period, was imported by the United States. Accumulations remaining in India approximated 3,000 pounds in May 1944. Production from this area probably will be negligible.

China and Malaya. - Occasional rumors have indicated that extensive pegmatite zones occur in Sinkiang, Southwest China. This area is rather inaccessible, and the natives are said to be reluctant to receive foreign visitors.

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The tin smelters of Malaya have accumulated large slag dumps in the course of tin reduction. Fansteel Metallurgical Corporation sampled and analyzed some of these dumps in 1939 and found that they contained approximately 3 percent Ta_2O_5, which indicates that some sections of the large alluvial tin deposits undoubtedly carry recoverable quantities of tantalit Upon examination, some of the deposits may indicate enough tantalite to justify its separation.

Conclusion. - Undoubtedly, as detailed knowledge of pegmatites is expanded and as new pegmatite zones are discovered in various parts of the world additional tantalite ore bodies likewise will be located. The impor tant uses of the metal justify the assembling of all available knowledge a periodic intervals to provide adequate data for supplying processing facilities.

PRODUCTION METHODS AND COSTS

South Dakota

Actual production costs heretofore assembled are somewhat sketchy at best, except for the operations in the United States described above. Th South Dakota properties were worked from the surface by both hand and mec cal means sporadically until 1935.

In the summer of 1937 some surface operations on Tantalum Hill were sumed, but the main work was accomplished in a 2-compartment inclined sha Operations have been described in detail by J. R. Guiteras, of the Bureau Mines.19/

It is interesting to note the operating costs at this property as gi in table 8:

TABLE 8. - Operating costs per ton of tantalite ore milled and per pound of tantalite concentrate produced, Black Hills, S. Dak.

Period covered: June 16 to June 30, 1938
Ore milled during the period, tons 371
Concentrates produced, pounds 1,610

	Cost per ton of ore milled	Cost per pound of tantali concentrate produced
Mining:		
Development	$0.305	$0.070
Stoping	.929	.214
Sorting	.354	.082
Trucking to mill	.131	.030
Supervision and office	.186	.043
Total mining	1.905	0.439

19/ Guiteras, J. R. Mining and Milling Methods and Costs at the Black H Tin Co., Tinton, S. Dak.: Bureau of Mines Inf. Circ. 7084, 1939, 16 pp.

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TABLE 8. - Operating costs per ton of tantalite ore milled and per pound of tantalite concentrate produced, Black Hills, S. Dak. (Cont'd.)

	Cost per ton of ore milled	Cost per pound of tantalite concentrate produced
Milling:		
Operating	$0.792	$0.182
Supervision and office	.185	.043
Total milling	0.977	0.225
Total milling and mining ..	2.882	.664

The rates of labor paid in the mine and mill and the number of men employed are shown in tables 9 and 10. A further break-down of these costs is given in Information Circular 7084.

TABLE 9. - Direct mine labor

Number	Occupation	Rate	Cost per day
2	Miners	$4.00	$8.00
2	Chute pullers	3.00	6.00
4	Ore sorters	3.00	12.00
2	Hoistmen	3.50	7.00
1	Truck driver	3.00	3.00
1/2	Blacksmith	4.50	2.25
11-1/2			38.25

TABLE 10. - Direct mill labor

Number	Occupation	Rate	Cost per day
2	Table men	$3.00	$6.00
1	Crusher man	3.00	3.00
1	Roustabout	3.00	3.00
1/2	Mechanic	4.00	2.00
1/2	Electrician	4.00	2.00
5			16.00

According to Fansteel Metallurgical Corporation, the operating costs were exceptionally high compared with the amount of ore actually recovered. As a result, in 1938 mining was discontinued, and since that time production has been negligible.

Australia

The first tantalite mining recorded was done in Australia. The deposits have already been described. The main producer was Tantalite, Ltd., largely controlled by Lady Deborah Buller Murphy. A. Kennedy was the superintendent in charge of company operations, which were principally at Wodgina and Strelley. In February 1943 he estimated for Foreign Economic Administration the costs of hard-rock operations based on his experience to 1939 as follows (table 11):

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Assumptions:

(a) 100 long tons of 60 percent Ta_2O_5 concentrates, annual productio of which was 78 long tons from Wodgina and 22 long tons from Strelley.

(b) 6 long tons of concentrates produced from 1,650 long tons of selected ore, which represents one-third of the mine-run ore.

In addition to the lode deposits heretofore described, the alluvial d posits in the Greenbushes area are quite important. They are 160 miles so of Perth and are readily accessible by rail and highway. In June 1943 Van Wagenen reported to Foreign Economic Administration the cost of operation a 5-week period during which time 120 cubic yards was mined and beneficiat by hand; the yield was 1.5 long tons of 65-percent (estimated) Ta_2O_5 ore. The costs are tabulated below:

Total cost of producing 1-1/2 short tons:

	£	s.	d.
Labor (150 shifts, at 32 shillings)	240	0	0
Supervision (at £12 per week)	60	0	0
Supplies (nominal, including sacks)	10	0	0
Communications (estimated)	15	0	0
Sampling and assaying (estimated)	20	0	0
Freight, by rail, to Brisbane from Greenbushes, £38:15:0 per short ton	58	2	6
Total, except royalty	403	2	6
Sales price	1,384	4	0
Net before royalty	981	1	6
Royalty, 10 percent "one working profit"	98	2	1.8
Profit	£882	19	4.2
Profit per short ton (round figure)	£589		($1,908)

Tantalite recovered per yard handled = 25 lbs.

Recommending mechanical operations, Van Wagenen estimated in detail costs of such operations:

On the mechanized operation it is difficult to see how costs ca exceed 4 shillings per yard and, if the ground yields an average of pounds (recovered) per yard of mineral, carrying 60 percent Ta_2O_5, t following figures would be attained.

Realization at Brisbane per short ton	777.78	2,520.00
Less freight Greenbushes to Brisbane	38.75	125.55
Value per ton at Greenbushes before costs and royalty	739.03	2,394.45

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Value per pound of ore	.36951	1.20
Value per yard (assume 2 lbs. recovered)..	.73902	2.40
Operating costs, complete, per yard (estimated at not over 4 shillings)	.20000	.6500
Profit, before royalty, per yard	0.53902	1.75
Royalty, 10 percent "of working profit" ..	.05390	.18
Net profit per yard	0.48512	1.57

Round figure: 9 shillings.

On 200 yards per day, 25 days per month:
Production: 10,000 lbs., 5 short tons, per month.
Profit: £450 per short ton, £2,250 per month.

Brazil

Ray Worley, who was on duty in Brazil for the Foreign Economic Administration for some time, in March 1944 estimated the average operating costs in detail:

We have cost figures on a group of producing altos working by hand. These costs do not include exploration and development. We base our estimates on a ratio of 3,300 tons of rock to be moved to each ton of tantalite produced.

The average cost per ton of rock is $1.025; therefore to produce from these altos 1 ton of tantalite would cost 3,300 x $1.025. Beneficiation, freight, taxes, and overhead vary, but 10 percent is a conservative estimate. That would amount to $341.32. A tantalite of 50 percent tantalum (pentoxide) content has a value on the new schedule of $2.70 per pound (of Ta_2O_5). A ton of tantalite would therefore contain 1,000 pounds of tantalum and be worth $2,700.00. We therefore have:

Cost: 3,300 x 1.025	$3,413.25
Processing, freight, etc.	341.32
	3,754.57
Value of tantalite	2,700.00
Net loss	1,053.57

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TABLE 11. - Summary of costs for hard-rock operations, Tantalite, Ltd., Australia
(4-week period)

Source of ore	Open-cut		Stoping		Ore dumps		Total	
Tons to mill	660		770		220		1,650	
	Per long ton of sorted ore							
	For this tonnage, £A	Per ton, s.	For this tonnage, £A	Per ton, s.	For this tonnage, £A	Per ton, s.	For total tonnage, £A	Per ton s.
Cost of mining and sorting:								
Supervision	16	0.48	28	0.73	-	-	44	0.53
Facework	390	11.82	660	17.15	-	-	1,050	12.72
Underground tramming	-	-	149	3.87	-	-	149	1.81
Hoisting mine ore	-	-	164	4.26	-	-	164	1.99
Hoisting open-cut ore	81	2.46	-	-	-	-	81	.98
Water and mine drainage	-	-	25	.65	-	-	25	.32
Surface ore carting	-	-	54	1.40	55	5.00	109	1.32
Total	487	14.75	1,080	28.06	55	5.00	1,622	19.67

	Per long ton of selected ore	
	Shillings	Dollars
Summary of costs at the mine and mill:		
Mining and sorting, per ton of ore ready to be milled	19.67	3.19
Milling	12.50	2.02
Sundry services	3.50	.57
Development, 50 feet each 4-week period ($16.20 per foot)	3.00	.49
Management and travel expense (£196.35 = $636.17)	2.38	.39
	41.05	6.65
After dump ore finished, mining rises to 22 shillings; total	43.38	7.03
Ratio of concentration: 1,650 long tons milled yielded 6 long tons of concentrates (6.72 short tons)	275 : 1	
Cost at the mine of a long ton of concentrates	275 x 43.38s. = £596.375 ($1,932.25)	

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	Per long ton of concentrates	
	£A	$US
Costs after mining and milling:		
Bags and bagging	1: 0: 0	$3.24
Trucking, mine to Port Hedland (70 miles)	2: 1: 6	6.723
Wharfage, at Port Hedland	13: 6	2.187
Water freight, Hedland to Brisbane	4: 0: 0	12.96
Wharfage, at Brisbane	10: 0	1.62
Total, bags and shipping	8: 5: 0	26.730
	Per long ton	
	£A	$US
Total operating costs:		
At the mining property	596.375	1932.25
Bags and shipping	8.250	26.73
Royalty, at 10 percent of sales price	85.944	277.81
Total expense	690.569	2236.79
Revenue: 60 percent Ta_2O_5 concentrate	777.778	2520.00
Operating profit: Per long ton of concentrates	87.209	283.21

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Four out of five properties explored will be abandoned because they will not produce enough to justify continuing operation. These explorations should properly be charged to the producing mines. Our estimates are that including these it would bring the number of tons of rock moved to each ton of tantalite produced to 9,786 tons. Naturally, the ratio would become lower as the production period of the altos are lengthening. From records kept by the Brazilian Department of Mines this should be brought down to from 6,000 to 6,500 tons. The mines are small and soon exhausted; hence it is necessary to carry on exploration work continually. Excluding the larger properties, of which there are only a few, the average production life of a property would not exceed 1-1/2 tons of tantalite. The greater majority of these are now closed down. Of the nearly 100 having been operated by Octaviano Bezerra, only 12 are working. Of the 162 controlled by Jose Marcelino, only 8 are operating. Of the 158 operated by Florencio Luciano, nearly all are down. Oscar Piquet & Cia. have shut down. S. A. Murray & Cia. have closed down. Carvalho & Cia., one of the best set-up operators who have their own engineering staff and are well financed, have said they are closing down for the duration. Silveira do Brasil & Cia. ordered all compressor operations to cease as of March 5th, but I consider this as a bluff, for they are making $25,000.00 to $30,000.00 per month from their scheelite contracts. Further, they have bought up and are continuing to buy all the good properties they can get their hands on.

Cost of mining on Alto Taboa[1/] with compressor service

18,184 tons of rock mined.
5,460.7 lbs. tantalite produced average 50 percent Ta_2O_5.

Value, 5,460.7 lbs. at $2.70 per lb.		$14,743.89
Compressor rental:		
519 hrs. at $0.775 per hour	$ 591.66	
Powder and fuse	3,404.00	
Labor	2,784.00	
Processing, freight, etc.	2,948.78	
Development	3,636.80	
Costs	13,365.24	13,365.24
Profit		1,378.65

1/ One of the more-promising zones.

This record was taken during the most-productive period of the operation. Alto Taboa is the most-outstanding producer of tantalite in Brazil.

It must be remembered that costs at some operations are higher than others; likewise the figures furnished by various producers were not audited nor were the records considered complete. The figures presented here are based on the revised price schedule in the appendix of this report.

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Southern Rhodesia

Operations in Southern Rhodesia have been under the supervision of the Department of Mines since early 1943. The Department has reported that "heads" contain 0.03 percent tantalite, or 0.6 pound per short ton of rock. Detailed accounts have been presented and are certified by the Auditor General of the Government of Southern Rhodesia. The following itemized statement of accounts is subject to later qualification:

	£ s. d.	
Expenditure recorded	11,179: 13: 0	
Balance, native pay	2: 13: 0	
Government royalty (estimated):		
October	4: 14: 8	
November	- - -	
December	5: 17: 3	
January	14: 7: 1	
Receipts to date		762: 5: 8
Balance value concentrates to come		2,925: 5: 7
Sale of stores to Lawrie		63: 4: 2
Value of plant		1,805: 0: 0
Balance		5,651: 9: 7
	11,207: 5: 0	11,207: 5: 0
Loss (approximate)	5,650: 0: 0	

The status of the mines in Southern Rhodesia has been mentioned briefly. However, to fully understand the accounts, the reader should know that operations were in a very primitive state until the Department assumed control. It was necessary to invest approximately 4,000 pounds sterling as capital expenditures. Considerable "dead" mining work was required before the pegmatite zones could be mined actively. Some work was strictly exploratory.

The first work in the area under Government supervision was mass mining of the pegmatite, and when this proved uneconomical selective mining on the favorable zones of mineralization was tried. Consequently, these costs represent mining and geological research as well as production charges. Ore produced during the period of accounting through January 1944 totaled 14,885 pounds of tantalite and simpsonite of approximately 53 to 55 percent Ta_2O_5 average grade.

Summary of costs. - The foregoing discussion gives a general idea of the variation in costs of operating tantalite properties in different parts of the world. Cost of operation at some deposits is low, while at others it is high. For example, mining alluvial deposits with substantial tantalite content costs considerably less than hard-rock mining.

Considering the average pegmatite occurrences now being mined for tantalite and applying the prices given in the revised price schedule appended hereto, the average deposit appears to contain about $1.00 in tantalite per ton, which would be considered very low in most mining operations. In some tantalite areas, however, the value per ton of crude rock mined is increased by recovery of beryl and other pegmatite minerals.

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TRANSPORTATION

In the primitive and isolated areas where tantalite deposits occur t ore, packed in bags, usually is carried on the backs of men or mules to modern transportation centers. Generally it is beneficiated or cleaned a some central point near direct transportation to the seaport.

In May 1942, when the supply of tantalite in the United States was e tremely low, arrangements were made whereby the Army Ferry Command and la the Army Transport Command would move tantalite to the United States in cargo transports. As service was extended to Africa, Australia, and othe areas tantalite was included in the high-priority cargo. During 1943 abo 474,000 pounds of ore was transported by air to the United States.

WORLD CONSUMPTION AND USES

Consumption prior to 1941, compared with the present rate, was negli gible. Small quantities of tantalum metal were used for certain radio tu rayon spinnerets, bayonet heaters, chemical ware, and speciality products calling for a high degree of resistance to corrosion. Sintered carbides for lathe tools required some ore, and small quantities of refined oxides were used in photographic lenses.

The chief consuming countries were the United States, Germany, and t United Kingdom. In 1938 German capacity was about 16 tons of ore, which yielded 1,000 pounds of tantalum metal of inferior quality and some sinte carbides. In the United Kingdom carbides were produced by direct reducti of the ore with carbon, so ore requirements were small. United States re quirements for ore were based on sales made by the processing company, Fansteel Metallurgical Corporation, North Chicago, Ill.

In considering uses a review of the unique properties of tantalum i necessary. These are listed below:

1. Ductile - can be cold-drawn to 0.001 inch diameter or rolled to 0.002 inch thickness.

2. Absorbs gases - will absorb 740 times its volume of hydrogen to produce a hard, brittle material.

3. Highly resistant to acid corrosion even at high temperatures.

4. Melting point, 2,850° C.

5. Tensile strength, 130,000 lbs. per square inch.

6. Density, 16.9.

Edward W. Engle gives an excellent review of the uses and limitatio of tantalum in a short paper entitled "Tantalum and Columbium," a chapte in Modern Uses of Nonferrous Metals published in 1935 by the American Institute of Mining and Metallurgical Engineers.

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New uses have been developed for the ore during the war. High-frequency radio and radar required quantities of metal far beyond the estimated maximum world production possibilities. The military collapse of the United Nations in Malaya and the Dutch East Indies isolated the world sources of natural rubber and necessitated construction of large synthetic-rubber plants in the United States. In the production of butadiene, one of the important types, large quantities of potassium tantalum fluoride are required as a catalyst. Expansion of armaments necessitated increased manufacture of carbide tools Development of infrared photography called for large quantities of pure tantalum oxide and further increased the need for tantalum ore. Of major importance, although requiring negligible quantities of metal, is the increased use of tantalum in surgery.

SUBSTITUTES

In the carbide-tool field various substitutes, including columbium carbides, have been employed during the war. Molybdenum and tungsten tools were increasingly utilized, although for certain purposes they were not considered as desirable as tantalum carbides. In radio-tube manufacture zirconium-coated molybdenum, platinum-coated molybdenum, and platinum and graphite have been substituted for tantalum. For some tubes these substitutions are not desirable, but in others they are acceptable. No satisfactory substitute has been developed for the butadiene catalytic use. For some chemical uses platinum has been considered as effective as tantalum. Molybdenum and other alloy metals may be used in place of tantalum for other purposes.

PRICE TRENDS

According to the 1940 issue of the Minerals Yearbook, tantalum metal sells for $65 to $73 per pound. In general, however, the price for tantalum varies with the type of material. Wire and sheets of various sizes and thicknesses are manufactured. Prices in 1943 ranged from $100 to $500 a kilogram.

Prices of ore before the war were subject to individual negotiation and in some instances fell within the range of prices in effect at the end of the first half of 1944. The price schedule shown in the appendix of this circular was in effect for United States Government purchases until July 1943. The penalties were attached to the price schedule in April 1943. Because of increased needs for tantalite, the revised schedule of prices and penalties (appendix) was placed in effect in July 1943.

PRICES, PRODUCTION, AND CONSUMPTION

Future prices for tantalite will depend largely upon the volume of production and the need for a consistent tonnage of ore. After the war, Germany may again require ore, and other countries may begin to process tantalite. Keen competition for the world ore supply may result, and if unstable market conditions prevail production will vary considerably. If, however, a stable price and market are maintained, the production rate will accord with

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the economics of mining operations. Undoubtedly, production could continue within the limits of the revised price schedule (appendix), at a rate that would supply world needs. It is expected that world post-war ore requirements will be considerably greater than pre-war needs.

PROCESSING FACILITIES

To produce tantalum a complicated chemical flow sheet requires the ore to be sintered, digested, precipitated, and reduced to metal powder. Products at various phases of the process can be refined to produce pure potassium tantalum fluoride and pure oxide. Impurities are eliminated in the course of processing.

The world's largest plant for processing tantalite is that of the Fansteel Metallurgical Corporation in North Chicago, Ill. Adjacent to the property of this company is the United States Government-owned Tantalum Defense Corporation plant. The only other tantalum plant was that of Siemen Halske, Charllotenburg, Germany, whose products apparently were inferior t those of the United States as evidenced by the producers' preference to purchase tantalum from the United States.

A number of companies are producing or have produced tantalum sintere carbides, among which are Firth-Sterling Products, Inc., and McKenna Metal in the United States Murex, Ltd., and Blackwell Metallurgical Works in th United Kingdom; and General Electric, Ltd., in Australia.

GOVERNMENT CONTROLS

There are no tariff controls on crude ore except some export duties assessed on ores in various countries. Belgian Congo, Brazil, and other countries impose such taxes.

During the war, the War Production Board found it necessary to contro the import and consumption of ore. General Imports Order M-63 prohibited tantalite imports except under Government ownership or specific exemption. Tantalite was removed from this order in late 1944. All tantalum producti was placed under allocation by Order M-150 on May 22, 1942. This act by t War Production Board was considered necessary because of the ever-increasi demands for metal.

In July 1942 there was approximately 4 months' supply of 45 percent average-grade tantalite in the United States. In mid-May 1944, based on requirements of the plants to operate at capacity, there was 1 year's supply of operating stocks containing 45 percent Ta_2O_5 in the United Stat

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APPENDIX

Principal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil

RIO GRANDE DO NORTE

Town and district	Name of mine	Location	Owner and/or operator	Remarks
ri-Acari...	Mutuca.....	9 km. toward Acari from Parelhas.	P.A. Costa, owner; Mineracao Serido, Ltd., operator.	Strike, EW. Poor producer.
)o.....	Monte Alegre.	5 km. from Acari toward Currais Novos.	Manoel T. Dantes, owner; Octaviano Bezerra, operator.	Strike, N. 25° E. Fair producer.
)o.....	Tanque Novo.	14.7 km. from Acari toward Sao Vicente.	Silvino A, Bezerra, owner and operator.	Strike, NE. Good producer.
)o.....	Brauna.....	Enroute to Mutuca.	P.A. Costa, owner; Mineracao Serido, Ltd., operator.	Strike, N. 55° W. Good producer.
)o.....	Cabeco do Meio.	do.	do.	Strike, N. 40° W. Fair producer.
)o.....	Cabeco do Josias.	Enroute from Parelhas to Acari, 9 km. E. on Fazenda Rd.	Possidonio Avelino Costa, owner; Mineracao Serido, Ltd., operator.	Strike, NS. Fair producer.
)o.....	Romao.....	Enroute from Parelhas to Acari, 9 km. E. on Fazenda Rd., 3 km. SE.	Synesio Pereira, owner; Mineracao Serido, Ltd., operator.	Strike, N. 20° W. Fair producer.
)o.....	Macambira...	..	do.	Strike, ESE. Poor producer.
ari-Carnauba.	Tonneca de Boa Sorte.	10 km. from Nova Palmeira Carnauba.	Rita Dias de Oliveira, owner and operator.	Strike, NS. Poor producer.
Do.....	Xique-Xique.	32 km. from Picui toward Carnauba.	Cia. Mineracao do Nordeste, owner and operator.	Strike, N. 70° E. N. 70° W. Poor producer.
Do.....	Francisco Felix.	5 km. from Picui toward Parelhas.	Francisco Felix, owner; Silveira Dantas, operator.	Strike, NS. Good producer.
Do.....	Cachoeira...	3.2 km. from Nova Palmeira toward Parelhas	A. Pereirade Santo, owner; Mineracao Serido, Ltd., operator.	Strike, NS. Good producer.
rrais Novos-erro Cora.	Cacador.....	20 km. from Lages toward Cerro Cora.	Manuel J. de Maria Santana, owner; Fernandes Silva, operator.	Strike, S. 62° E.; dip, NE. Small producer.

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Principal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'd

Town and district	Name of mine	Location	Owner and/or operator	Remarks
Currais Novos-Cerro Cora.	Quimangas ..	4 km. from Cerro Cora toward Angicos.	Jose Soares de Medeiros, owner; Servulo Pereira, operator.	Pegmatite p. Good produc
Do.....	Patrimonio..	10 km. from Cerro Cora toward Currais Novos.	Servulo Pereira, owner and operator.	Good produc
Do.....	Jose Pinto..	3 km. from Cerro Cora toward Angicos.	Jose Pinto, owner; Servulo Pereira, operator.	Pegmatite plugs. Go producer.
Do.....	Manoel Lopes.	28 km. from Cerro Cora to S. Thome.	Manoel Lopes, owner and operator.	Pegmatite plugs. Sm producer.
Do.....	Serra Preta.	4.5 km. from Serra Cora toward Angicos, 3.2 km. on Fazenda Rd.	Jose Antonio de Maria, owner; Oscar Piquet & Cia., operator.	Strike, EW. Small producer.
Currais Novos-Currais Novos.	Morro do....	16.3 km. from Currais Novos toward Sao Vincente.	Thomas Galvon, owner and operator.	Strike, NE. Small produ
Do.....	Mourao.....		Laurentino Pereira Araujo, owner; Plinio Lemos, operator.	Small produc
Jardim do Serido-Jardim do Serido.	Sao Goncalo.	2.2 km. from Jardim toward Sao Jose, 15 km. N. on Fazenda Rd.	Isabel Medeiros-Adelia Leocadiade Medeiros, owners; Joaquim Alves do Silva, operator.	Strike, NS. Good produ
Do.....	Currais Novos.	17.9 km. from Parelhas toward Jardim, 4.5 km. NE.	Jose Moises do Mereiros, owner and operator.	Strike, N. W. S 35° E Small prod
Parelhas-Parelhas.	Vaiquem Quer.	22 km. from Parelhas toward Cobra.	Brez Jose Dantes, owner; Mineracao Serido, Ltd., operator.	Strike, EW. Small producer.
Do.....	Urubu No. 2.	Enroute to Barra from Parelhas; W. on Fazenda Rd.	Jose Tiburcio de Lima, owner; Mineracao Serido, Ltd., operator.	Strike, EW. Fair produ
Do.....	Pedra Amuada.	21 km. from Parelhas toward Cobra.	Antonio Casimiro Medeiros, owner; Mineracao Serido Ltd., operator.	Strike, N. E. Small ducer.

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incipal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'd.)

Town and district	Name of mine	Location	Owner and/or operator	Remarks
relhas-relhas.	Alto Malhada Vermelha.	2 km. from Parelhas toward Acari.	Jose Arnaldo de Mereiros, owner and operator.	Strike, NS. No production record.
Do.....	Sao Sebastiao.	4 km. from Parelhas toward Barra, 4 km. SW.	J. Jardilina de Lima, owner and operator.	Strike, NW.-SE. Small producer.
Do.....	Urubu.....	2 km. from Barra, N.-NW. to Fazenda.	Francisco Vitorino, owner; Otacilio G. Dantas, operator.	Strike, EW. Good producer.
Do.....	Caracara....	2 km. from Barra to Fazenda.	Heirs of Vitoriono Dantas, owners; Octacilio G. Dantas, operator.	Strike, EW. Small producer.
Do.....	Saco do Boi.	10 km. from Barra to Pedras Lavrada, 2 km. SW.	Graciliano Lordao, owner; Ovidio Pereira Dantes, operator.	Strike, N. 50° E. Small producer.
Do.....	Timbauba....		Gregorio Gondon da Silva, owner; Mineracao Serido Ltd., operator.	Strike, NE.-SW. Small producer.
Do.....	Buqueirao...	1-1/2 km. from Parelhas toward Barra, 1-1/2 km. SE.	Jose Marcelino de Oliveira, owner and operator.	Strike, N. 45° W. Good producer.
Do.....	Algodao.....	20 km. from Parelhas toward Barra.	Sebastiao Fernandes, owner; Mineracao Serido Ltd., operator.	Strike, EW. Small producer.
Do.....	Buqueirao...	18 km. from Parelhas toward Barra, 1 km. SE.	Joaquim Francisco, owner; J. Marcelino Oliveira, operator.	Strike, N. 45° W. Good producer.
relhas-Equador	Clemente....	8 km. from Equador toward Parelhas.	Clemente Berzerra da Cunha, owner; Jose Marcelino Oliveira, operator.	Strike, NNE.-SSW. Small producer.
Do.....	Alto de Luiz Gregorio.	11.5 km. from Barra to Joana, 2 km. SE.	Luiz Gonzaga de Araujo, owner; Jose Marcelino de Oliveira, operator.	Strike, NE.-SW. Small producer.
Do.....	Joana.....	11 km. from Barra toward Boa Vista.	Mineracao Seudo Ltd., owner and operator.	Strike, WNW.-ESE. No production record.

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Principal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont

Town and district	Name of mine	Location	Owner and/or operator	Remarks
Parelhas-Equador.	Carnaubinha.	3.5 miles from Parelhas toward Barra, 1.5 miles SE. on Nova Palmeiro Rd., 2.7 miles E.	Jose Joaquim Ferreira Lima, owner; Mineracao Serido Ltd., operator.	Strike, EW. Good produ
Do.....	Malhada Grande.	6 km. from Barra toward Equador.	Antonio Gregorio de Medeiros, owner; Otacilio Gregorio, operator.	Strike, NE. Good produ
Do.....	Tanquinhos No. 2.	3 km. from Equador to Boa Vista.	Jose Marcelino de Oliveira, owner and operator.	Strike, EW. Small producer.
Do.....	Jacu No. 3..	8 km. from Equador toward Boa Vista.	Maria Madalena da Conceicao, owner; Jose Marcelino de Oliveira, operator.	Strike, NW. Small producer.
Do.....	Gavio.....	2 km. from Barra on Fazenda Rd.	Heirs of Francisco Vitorina Dantas, owner; Octacilio Gregorio Dantas, operator.	Strike, N. E. S. 60 Small producer.
Do.....	Gamenho.....	2 km. from Barra WNW to Fazenda; 2 km. SW.	Izidio Clemente da Fonesca, owner; Octacilio Gregorio Dantas, operator.	Strike, EW. Good produ
Do.....	Massilon No. 2.	7 km. from Equador toward Boa Vista.	Massilon Lino da Passos, owner; Jose Marcelino de Oliveira, operator.	Strike, NW. Small producer.
Do.....	Jacu No. 2..	8 km. from Equador toward Boa Vista.	Herdeiros de Jose Marinho dos Santos, owner; Jose Marcelino de Oliveira, operator.	Strike, NW
Do.....	Tanquinhos..	3 km. from Equador toward Boa Vista.	Manoel da Silveira Dantas, owner; Jose Marcelino de Oliveira, operator.	Strike, NE. Small producer.
Do.....	Jacu No. 1..	7 km. from Equador toward Boa Vista.	Manoel Constantino de Moroes, owner; Jose Marcelino de Oliveira, operator.	Strike, NE. Fair prod
Do.....	Massilon No. 1.	do.	Massilon Lino dos Passos, owner; Jose Marcelino de Oliveira, operator.	Strike, NW. Small producer.

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incipal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'd.)

Town and district	Name of mine	Location	Owner and/or operator	Remarks
relhas-quador.	Mamoes.....	5 km. from Equador toward Parelhas.	Jose Marcelino de Oliveira, owner and operator.	Strike, NNE.-SSW. Good producer.
Do.....	Camarinoas No. 1.	11.5 km. from Barra toward Joana, 8 km. SSE.	Antonio Maximiano Costa, owner; Silveira Dantas, operator.	Strike, EW. Small producer.
Do.....	Tanquinhos No. 2.	3 km. from Equador toward Boa Vista.	Jose Marcelino de Oliveira, owner and operator.	Strike, EW. Fair producer.
Do.....	Tanquinhos No. 1.	do.	Jose Marcelino de Oliveira, owner and operator.	Strike, EW. Small producer.
relhas-Santo nna J. erido.	Boneca	18 km. from Parelhas toward Equador.	Eduardo Ferreira de Azevedo, owner; Octaviano Bezerra, operator.	Strike, NS. Small producer.
ges-Lages...	Corcunda....	28 km. from Lages toward Sao Thome.	Milton Varela, owner.	Strike, N. 15° W. Good producer.
Do.....	Sao Jose....	23 km. from Lages toward Natal, 5 km. S. toward Fazenda.	Manoel Ribeiro de Lima, owner and operator	Strike, NW. Small producer.
Do.....	Ubara Placer	26 km. from Lages toward Natal, 8 km. SE. to Fazenda.	Pablo Lopes, Varilla owner; Francisco Alves Maya, operator.	Strike, NNW. Small producer.
Do.....	Morro das Cabras.	38 km. from Lages toward Sao Thome.	Olegario Costa, owner Norman S. Pressler, operator.	No production record.
Do.....	Morro do Acudi.	34 km. from Lages toward Sao Thome.	Olegario Costa, owner Norman S. Pressler, operator.	Do.
Do.....	Aviao.....	3 km. from Barra to Cochoeira, 1 km. NE.	Margarida Teixeira, owner; Paulo Teixeira, operator.	Strike, N. 5° E. No production record.
Do.....	Alto Estrada do Felix.	30 km. from Lages to Caicara.	Joao Dionisio da Camara, owner; Olimpio Procapio Moura, operator.	Small producer.
Do.....	Bomfin.....	25 km. from Lages toward Bomfin, 2 km. SW.	Jophet Batista, owner; Aristofanes F. Silva, operator.	Pegmatite plug. Small producer.
Do.....	Cachoeira...	34 km. from Lages toward Sao Thome.	Olegario Costa, owner; Norman Pressler, operator.	Outcrop. No production record.

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Principal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'd

Town and district	Name of mine	Location	Owner and/or operator	Remarks
Lages-Lages...	Xica.....	18 km. from Lages toward Bomfin.	Jose Alfran Galvao, owner; Aristofanes F. Silva, operator.	No productio record.
Do.....	Santo Antonio.	30 km. from Lages toward Natal.	Manuel Ribeiro J. Feitosa, owner and operator.	Strike, S. E. Small ducer.
Lages-Caicara.	Rio Novo....	30 km. from Lages toward Natal, 15 km. to Sao Thome.	Jose Ziza de Ferreira, owner and operator.	Strike, N. Small producer.
Do.....	Canto da Garrota.	30 km. from Lages toward Natal, 6 km. E. toward Fazenda.	Jeronimo Gomes, owner; Pablo Teixeira, operator.	Strike, 52° Small producer.
Sao Thome-Sao Thome	Piabos.....	5 km. from Sao Thome toward Lages.	Pedro Pereira, owner; Antonio Pereira, operator.	Strike, N. N. 47° E. producer.
Do.....	Cham da Serrinha.	11 km. from Caicara toward Feitosa.	Sebastiana Medeiros, owner; Aristofanes Fernandes, operator.	Small produ
Do.....	Cabeio Rico.	2 km. from Caicara toward Feitosa.	Manoel de Lima, owner; Aristofanes Fernandes, operator.	Strike, N. Small producer.
Do.....	Serrinha....	25 km. from Lages to Bomfim, 6 km. NE.	Sebastiana Medeiros, owner; Aristofanes-Fernandes, operator.	Do.
Do.....	Gameleira...	do.	Ivo Lopes de Medeiros, owner; Aristofanes Fernandes, operator.	Do.
Do.....	Ubaeira.....	12 km. from Sao Thome to Cerro Cora, 6 km. on Ubaeira Rd.	Francisco Texeira Chagas, owner; Fernando Gomes Pedroza, operator.	Do.
Do.....	Alto da Cruz	30 km. from Lages toward Natal, 12 km. toward Serra da Gameleira.	Joaquim Roberto da Silva, owner; Fernando Gomez Pedroza, operator.	Strike, N. Small producer.
Do.....	Lameira.....	25 km. from Lages toward Bomfim, 6 km. through bush.	Jose Cavalconti de Lima, owner; Aristofanes F. Silva, operator.	Small produ

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ncipal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'd.)

Town and district	Name of mine	Location	Owner and/or operator	Remarks
Thome- o Thome.	Alto da Beleza.	30 km. from Lages toward Caicara, 6 km. toward Serro Gameleira.	Francisco Januario, owner; Olimpio Procopio Moura, operator.	Small producer.
o.....	Juba.....	11 km. from Sao Thome toward Lages, 5 km. E. of Fazenda.	Florencio Luciano, owner and operator.	Strike, N. 65° E. Small producer.
o.....	Caicara.....	11 km. from Sao Thome, 9.8 km. E.	Florencio Luciano, owner and operator.	Strike, N. 32° E. Small producer.
o.....	Alto Sao Jose.	30 km. from Lages toward Caicara.	Antonio Roberto da Silva, owner Olimpio Procopio Moura, operator.	Small producer.
o.....	Mussu.....	7 km. S. from Sao Thome.	Reynel Pereira, owner and operator.	Strike, N. 68° E. Small producer.
ui-Picui...	Umburana No. 2.	4 km. from Picui toward Pedra Lavrada, 23 km. toward Fazenda.	Luis Sezenando Dantas, owner; Joaquim Ozevedo Maia, operator.	Small producer.
o.....	Acude.....	14.4 km. from Picui to Carnauba, 3.5 km. NNW. toward Fazenda.	Maria do Carmo Dantas, owner; Mineracao Serido Ltd., operator.	Strike, NS. Small producer.
o.....	Saquinho....	do.	Raimundo Sales, owner; Mineracao Serido, Ltd., operator.	Strike, N. 30° E. Small producer.
o.....	Quixabeira..	13 km. from Picui toward Frei Martinho, 4 km. N. toward Conceicao.	Jose Macedo, owner; Pleno Maredo, operator.	Strike, NS. Fair producer.
o.....	Tanque Grande.	11 km. from Picui toward Pedra Lavrada.	Antonio Floroenzo, owner; Mineracao Serido Ltd., operator.	Strike, NS. Small producer.
o.....	Chapeuzinho.	6 km. from Picui toward Coite, 1 km. NW.	Austiano Pinheiro, owner; Plinio Lemos, operator.	Strike, NS. Small producer.
o.....	Acaua.....	2-1/2 km. from Picui toward Campina.	Elmano Mauricio da Costa, owner; Plinio Lemos, operator.	Strike, N. 60° E. No production.

4

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Principal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'

Town and district	Name of mine	Location	Owner and/or operator	Remarks
Picui-Picui	Pedra Preta	4 km. from Picui toward Campina.	Padre Jose da Cuhna Barros, owner; Mineracao Serido Ltd., operator.	Strike, NS. No product record.
Do.....	Cazados.....	5 km. from Picui toward Frei Martinho.	Manuel Garcia de Araujo, owner; Mineracao Serido Ltd., operator.	Strike, NS. Small pro
Do.....	Varzea.....	4 km. from Picui toward Campina.	Antonio Dionizio Macedo, owner, Mineracao Serido Ltd., operator.	Do.
Do.....	P-Q-P-39....	11 km. from Picui toward Pedra Lavrada, 2 km. toward Tanquinhos.	Jose Franklin de Macedo, owner; Mineracao Serido Ltd., operator.	Strike, 25 Small pro
Do.....	Luzaria-Luzitania-Luzeiro.	4 km. from Picui toward Campina.	Severino Ramos da Luz, owner; Mineracao Serido Ltd., operator.	Strike, NS production record.
Do.....	Alto Cortume de Cima.	4 km. from Picui toward Campina, 9 km. toward Estrada Nova Olinda.	Thomas Germano Gomes, owner; Jose Mauricio da Costa, operator.	Strike, NS Small pro
Do.....	Alto do Cortume de Baixo.	4 km. from Picui toward Campina, 9 km. toward Estrada do Nova Olinda.	do.	Do.
Do.....	Tanquinhos..	11.5 km. from Picui toward Nova Palmeira, 3 km. SSW.	Vincente Ferreira de Macedo, owner and operator.	Strike, N SSW. Goo ducer.
Do.....	Malcacheta (Cruzeiro).	1-1/2 km. NW. toward Frei Martinho.	Joventino Enriques, owner; Silveira Brasil & Co., operator.	Strike, N Small pr
Do.....	Angico Torto	7 miles from Picui toward Novo Palmeira, 2 miles toward Tanquinhos.	Manuel Valerio de Araujo, owner; Severino Ramos da Luz, operator.	Strike, E Small pr

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cipal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'd.)

Town and district	Name of mine	Location	Owner and/or operator	Remarks
i-Picui...	Malacheta...	13 km. from Picui toward Frei Martinho, 4-1/2 km. NE. toward Caussu Fazenda.	Ananias Ferreira, owner and operator.	Strike, EW. Small producer.
).....	Malhada de Areia.	2 km. from Picui to Frei Martinho.	Jose Edenio Dantas, owner; Jose Maruicio, operator.	Outcrop. No production record.
).....	Morada Nova.	5 km. from Picui toward Frei Martinho, 15 km. W. to Carnauba.	Santino Maria de Araujo e Filhos, owner; Jose Mauricio, operator.	Strike, NNW.-SSE. Small producer.
).....	Caraibeira..	6 km. from Picui toward Novo Palmeira.	Heirs of Zuzi Barros, owners; Vincente Ferreira Macedo, operator.	Outcrop. No production record.
).....	Alto do Poste.	2 km. from Picui toward Pedra Lavrada.	Padre Apolonio Guadencio, owner; Octaviano Bezerra, operator.	Small producer.
).....	Cabeca do Damiao.	5 km. from Picui toward Frei Martinho.	Rota Dias de Oliveira, owner and operator.	Strike, NS. Good producer.
).....	Boniteiza (Viracao).	4.8 km. from Picui toward Nova Palmeira.	Jose Fernandes do Nascimento, owner; Francisco Fernandes Azenedo, operator.	Strike, NS. Fair producer.
i-Frei tinho.	Iria Dantas.	16 km. from Frei Martinho toward Picui, 56 km. WSW. toward Fazenda.	Iria Carolina Dantas, owner and operator	Strike, EW. No production record.
).....	Volta de Cima.	18 km. from Frei Martinho to Carrapateira, 6-1/2 km. NE.	Jose Mauricio da Costa, owner and operator.	Strike, NS. No production record.
).....	Volta de Baixo.	18 km. from Frei Martinho toward Alto Carrapateira, 6 km. NNE.	do.	Strike, NS. Small producer.
).....	Frei Martinho.	3 km. from Frei Martinho.	Januncio Pereira da Silva, owner; Plinio Lemos, operator.	Strike, NS. Small producer.

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Principal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'd

Town and district	Name of mine	Location	Owner and/or operator	Remarks
Picui-Frei Martinho	Cabore.....	24 km. from Picui toward Frei Martinho, 4 km. W. toward Fazenda.	Col. Mauricio, owner and operator.	Strike, N. 7 W. Good pr ducer.
Do.....	Alto da Pedreira.		Francisco Florencio Bezerra, owner; Plinio Lemos, operator.	Outcrop. No production record.
Do.....	Alto Branco.	1.8 km. from Frei Martinho toward Currais Novos, 18 km. toward Caciassa.	Joaquim Domingo, owner; Jose Mauricio, operator.	Strike, NS. Good produc
Do.....	Carropateira.	1.8 km. from Frei Martinho toward Currais Novos, 15 km. NE. on Caciassa Rd.	Pocidinio Pereira, owner; Jose Mauricio, operator.	Strike, NW. Small producer.
Do.....	Quixaba.....	1.8 km. from Frei Martinho toward Currais Novos.	Joaquim Domingo, owner; Jose Mauricio, operator.	Strike, NS. Fair produc
Do.....	Vicente.....	6 km. from Martinho toward Picui, 5.6 km. SW. on Fazenda Rd.	Vicente Ferreira de Macedo, owner; Octaviano Bezerra, operator.	Strike, EW. Small producer.
Do.....	Alto de Lino No. 1.	4 km. from Frei Martinho, 6.3 km. WSW. on Fazenda Rd.	Lino Ferreira de Macedo, owner; Octaviano Bezerra, operator.	Strike, NW. Fair produ
Picui-Frei....	Concessao (Jose Canuto).	1.8 km. from Frei Martinho toward Currais Novos, 10.2 km. on Cauassa Rd.	Alexandrina Maria Conceicao, owner; Octaviano Bezerra, operator.	Strike, N. S. Fair p ducer.
Picui-Frei Martinho.	Boi Manso...	14 km. from Picui toward Frei Martinho.	Antonio Modesto, owner; Octaviano Bezerra, operator.	Outcrop. N production record.
Do.....	do.	10 km. from Frei Martinho toward Picui.	Iria Carolina Dantas, owner; Plinio Lemos, operator.	Outcrop. S producer.

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ncipal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'd.)

Town and district	Name of mine	Location	Owner and/or operator	Remarks
ui-Frei rtinho.	Lisdora Armaro.	10 km. from Frei Martinho toward Picui, 4 km. W.	Isidora Armaro, owner; Plinio Lemos, operator.	Small producer.
o.....	Pou de Arco.	10 km. from Frei Martinho toward Picui, 4 km. W.	Sebastiao Tertuliano Silva, owner; Plinio Lemos, operator.	Outcrop. Small producer.
ui-Pedra vrada.	Grande.....	6-1/2 km. from Pedra Lavrada.	Severino Ferreira, owner; Mineracao Serido Ltd., operator.	Strike, NE.-SW. Small producer.
o.....	Teceira Quixaba.	5 km. from Pedra Lavrada SW., 1-1/2 km. toward Alto do Toco.	Zacarias Agostinho, owner; Mineracao Serido Ltd., operator.	Strike, NS. No production record.
o.....	Do Toco.....	5 km. from Pedra Lavrada.	Pedro Firmino, owner; Mineracao Serido, Ltd., operator.	Strike, N. 15° E. Small producer.
o.....	Maracaja....	5.5 km. from Pedra Lavrada toward Picui, 3 km. SW. toward Fazenda.	Pedro C. de Medeiros, owner; Bezerra & Sposito, operator.	Strike, NE.-SW. Small producer.
o.....	Biquinho....	7.2 km. from Pedra Lavrada toward Campina, 4.8 km. SW. toward Serra Branca.	Mabilon Ferreira, owner; Octaviano Bezerra, operator.	Strike, NS. Small producer.
o.....	Malhada da Pedra.	4 km. from Pedra Lavrada.	Octaviano Bezerra, operator.	Outcrop. Fair producer.
o.....	Barra Dos Flexos.	8 km. from Pedra Lavrada toward Soledade, 9 km. SE. toward Serra Branco.	Antonio Oliveira, owner; Fleury Gomes Soares, operator.	Strike, N. 35° E. Small producer.
o.....	Salgadinho..	8 km. from Pedra Lavrada toward Soledade, 9 km. SE. toward Serra Branco.	Manoel Barbosa, owner; Fleury Gomes, operator.	Strike, N. 35° E. Small producer.
ui-Nova lmeira.	Formigao....	2.7 km. from Nova Palmeira towards Parelhas, 3.4 km. ENE. toward Canoa Fazenda.	Jose Sequeira Silva, owner and operator.	Strike, NE.-SW. Small producer.

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Principal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'd

Town and district	Name of mine	Location	Owner and/or operator	Remarks
Picui-Nova Palmeira.	Malidada Escondida.	2 km. from Nova Palmeira toward Parelhas, 5 km. NE. toward Canoa Fazenda.	Tomas Lorenco, owner; Antonio Flanklin Macedo, operator.	Strike, 50° 30° EW.
Do.....	Maldada Escondida No. 2.	do.	Tomas Lorenco, owner; Antonio Flanklin Madeira, operator.	Strike, 300° 500° NS. S producer.
Santa Luzia-Santa Luzia.	Quartzo Roseo.	2.5 km. from Humayta toward Junco.	Jader Silva de Medeiros, owner; Oscar Piquet & Cia., operator.	Strike, N. 7 E. Small p ducer.
Do.....	do.	11 km. from Natal Rd. toward Santa Luzia.	Jader Silva de Medeiros, owner; Oscar Piquet & Cia., operator.	Small produc
Do.....	Tigre.....	3 km. from Humayta toward Junco, 1 km. SW. toward Bella Vista mine.	Francisco Teitao, owner; Oscar Piquet & Cia., operator.	Strike, S. E. Small ducer.
Do.....	Bella Vista.	3 km. from Humayta toward Junco, 1 km. SW.	Francisco Leitao, owner; Oscar Piquet & Cia. operator.	Strike, S. E. Small ducer.
Do.....	Fundamento..	9 km. from Junco toward Santa Luzia.	Jader Silva de Medeiros, owner; Oscar Piquet & Cia., operator.	Strike, N. E. Small ducer.
Do.....	Calma Paz...	2 km. from Humayta to Junco, 1 km. N.	Jader Silva de Medeiro, owner; Oscar Piquet & Cia., operator.	Strike N. E. Small ducer.
Do.....	Christaes...	12 km. from Junco toward Santa Luzia, 2-1/2 km. E.	do.	Strike, N. E. Small ducer.
Do.....	Moro Branco.	7 km. from Junco toward Santa Luzia, 1 km. W.	do.	Strike, N. E. Small ducer.
Do.....	Amazones....	2 km. from Humayta to Malvas.	do.	Strike, N. W. Small ducers.
Do.....	Lyra No. 1..	2 km. from Humayta toward Malvas. 1 km. SW.	do.	Strike, N. E. Small ducer.

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cipal tantalite deposits, Rio Grande do Norte and Paraiba, Brazil (Cont'd.)

Town and district	Name of mine	Location	Owner and/or operator	Remarks
a Luzia-ta Luzia.	Humayta.....	5 km. S. from Humayta.	Jader Silva de Medeiro, owner; Oscar Piquet & Cia., operator.	Strike, N. 78° W. Small producer.
.....	Pedra E Col.	4 km. from Humayta toward Junco.	do.	Strike, N. 4° W. Small producer.
.....	Lyra No. 2..	2 km. from Humayta toward Malvas, 1 km. SW.	do.	Strike, N. 82° E. Small producer.
.....	Lyra No. 3..	2 km. from Humayta toward Malvas, 1 km. SW.	do.	Do.
a Luzia-Jose.	Ananias.....	31 km. NE. toward Santa Luzia.	Ananias Marks, owner; Oscar Piquet & Cia., operator.	Strike, N. 60° W. Small producer.
.....	Alto da Raposa No. 1	16.9 km. from Santa Luzia NE.	Eudoxia Marin da Conceicao, owner; Estacio Santo Maior, operator.	Strike, N. 50° E. Small producer.
a Luzia-ede.	Sao Memede..	1.5 km. from Sao Memede to Santa Luzia.	Filepe Nery Cobal, owner; Oscar Piquet & Cia., operator.	Strike, S. 30° E. Small producer.
e-Coite...	Santo No. 3.	22 km. from Campina toward Pocinhos, 33 km. on Barra Rd.	Octaviano da Costa Ramos, owner; Oscar Piquet & Cia., operator.	Strike, NS. Small producer.
eiro-Jo-ira.	Boa Vista...	6.8 km. from Barra to Parelhas, 1.9 km. N. on Fazenda Rd.	Jonathan Ferreira, owner; Oscar Piquet & Cia., operator.	Strike, N. 50° E. Fair producer.
eri-Sol-d.	Peba.....	36 km. from Barra toward Primevira.	Claudino da Costa Ramos, owner; Oscar Piquet & Cia., operator.	Strike, N. 40° E. Small producer.
.....	Facheiro....	do.	do.	Strike, N. 45° E. Small producer.

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Schedule of prices and penalties for tantalite ore[1/]

Ta_2O_5 contained in tantalite ore, percent	Price per pound Ta_2O_5 contained	Ta_2O_5 contained in tantalite ore, percent	Price per pound Ta_2O_5 contained
40	$1.20	56	$1.94
41	1.25	57	1.98
42	1.30	58	2.02
43	1.35	59	2.06
44	1.40	60	2.10
45	1.45	61	2.14
46	1.50	62	2.18
47	1.55	63	2.22
48	1.60	64	2.26
49	1.65	65	2.30
50	1.70	66	2.35
51	1.74	67	2.40
52	1.78	68	2.45
53	1.82	69	2.50
54	1.86	70	2.55
55	1.90		

1/ Fractions pro rata. Ores containing 35 percent or more Ta_2O_5 but less than 35 percent, $1.05 per pound of Ta_2O_5 content. Ores containing 30 percent or more Ta_2O_5 but less than 35 percent, $0.95 per pound of Ta_2O_5 content.

PENALTIES

Ores analyzing less than 60 percent combined Ta_2O_5 and Cb_2O_5, penalty of 1 cent ($0.01) per pound of Ta_2O_5 content for each full percent below 60, fractions pro rata.

Ores analyzing more than 6 percent combined SnO_2 and TiO_2, penalty of one-half cent ($0.005) per pound of Ta_2O_5 content for each percent above 6, fractions pro rata.

Ores analyzing more than 3 percent SnO, a penalty of 2-1/2 cents ($0.025) per pound of Ta_2O_5 content for each percent above 3, fractions pro rata.

Ores analyzing more than 3 percent TiO_2, a penalty of 2-1/2 cents ($0.025) per month of Ta_2O_5 content for each percent above 3, fractions pro rata.

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Revised schedule of prices and penalties for tantalite ore[1/]

Ta_2O_5 contained in tantalite ore, percent	Price per pound Ta_2O_5 contained	Ta_2O_5 contained in tantalite ore, percent	Price per pound Ta_2O_5 contained
30	$1.30	56	$3.12
31	1.37	57	3.19
32	1.44	58	3.26
33	1.51	59	3.33
34	1.58	60	3.40
35	1.65	61	3.47
36	1.72	62	3.54
37	1.79	63	3.61
38	1.86	64	3.68
39	1.93	65	3.75
40	2.00	66	3.82
41	2.07	67	3.89
42	2.14	68	3.96
43	2.21	69	4.03
44	2.28	70	4.10
45	2.35	71	4.17
46	2.42	72	4.24
47	2.49	73	4.31
48	2.56	74	4.38
49	2.63	75	4.45
50	2.70	76	4.52
51	2.77	77	4.59
52	2.84	78	4.66
53	2.91	79	4.73
54	2.98	80	4.80
55	3.05		

1/ Fractions pro rata.

PENALTIES as follows, fractions pro rata: The price per pound of Ta_2O_5 will be reduced by 2 cents for each percent under 60 percent minimum combined tantalum and columbium pentoxide.

The price per pound of Ta_2O_5 will be reduced by 1 cent for each percent in excess of 6 percent combined SnO_2 plus TiO_2.

The price per pound of tantalum pentoxide will be reduced by 3-1/2 cents for each percent in excess of 3 percent SnO_2.

The price per pound of Ta_2O_5 will be reduced by 3-1/2 cents for each percent in excess of 3 percent TiO_2.

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Mines and producers, Belgian Congo and Uganda (fig. 3)

Belgian Congo:

1. Manono mines } - Geomines.
   Kamola mines }
   Kalu-Kania area - Sermikat.
2. Belia deposit - Symetain.
3. Kamisuku and Likulu mines - Symetain.
4. Kasengesa area - Cobelmin.
5. Lubilu deposit - Cobelmin.
6. Molongodima area - Cobelmin.
7. Kasese area - Gobelmin and C. N. Ki.
8. Kikalai, Kaozi, and Moemba mines (Kabambare area) - Soc. Miniere du Maniema et de Nyangue.
9. Makalopongo mine - M. G. L.
10. Tshamaka area - M. G. L.
11. Tchubi mine - Minetain.

Uganda:

12. Kayonza area - James Gastrell, Mining Eng., Mbarara.
13. Buganda area (north of Kampala) - A. S. Gondalaker, Kampala.
14. Mbarara - A. Dokelman, Mbarara.
    Buhwezi - R. Jemubi and J. E. A. Collins, operating separately.
    Dwata (Ruamypara) - J. E. A. Collins.
    Kakanena, Ruakerenze - W. J. T. Young, Mbarara Ngoma near Dwata.
    Ruhuma - P. E. Patel 7 Co., Mbarara.

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